VOL. XVIII • NO. 2 • APRIL 1980

DEVELOPMENT DIGEST

The DEVELOPMENT DIGEST is prepared for the Agency for International Development by the National Planning Association, a private, non-profit organization in Washington, D.C.

We would appreciate comments of an editorial nature and suggestions of material for possible inclusion in the DIGEST. Please address:

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Use of funds for printing this publication approved by the Director of the Bureau of the Budget June 2, 1966.

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DEVELOPMENT DIGEST

A quarterly journal of excerpts, summaries, and reprints
of current materials on economic and social development

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Prepared by the National Planning Association

for

Agency for International Development, U.S. Department of State

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Volume XVIII, Number 2 April 1980

(Unless otherwise specified, money values will be expressed in U.S. dollars)

Results of Questionnaire Sent to Readers of Development Digest

A series of questions was put on a card in the first page of the January 1979 issue of the Development Digest in such a way that readers could remove the card, answer the questions, and mail it to AID (the Agency for International Development) in Washington, U.S.A. The questions were: first, a list of different subjects, asking readers to check those they would like to see in future Digests, and double check those that interested them most strongly; and secondly, a few general questions on the Digest content and its usefulness to readers. Two hundred and ten people responded, and the results are shown in Table 1.

If the opinions expressed here are representative of our general readership, some inferences may be made. Perhaps the most important is that Digest readers do have a variety of different interests, so that the journal should continue to supply a diversity of subjects: this seems to indicate that we should try to cover different topics in each issue (as we do), as well as a range of different subjects during a year. There are some patterns in the amounts of interest shown in these responses. The two most popular subjects, Strategies for Development, and Planning-Project Appraisal, point to a strong concern with the directions and purposes of development and the way it should be guided. Closely behind these two comes Agriculture which, together with subjects such as Village Technology, Social Change and Marketing-Cooperatives suggest that rural development has a relatively high priority in the minds of respondents. Employment Generation and Population are two basic areas of concern. And in the upper-middle level of priorities are technological subjects like Energy Alternatives, Science-New Technology, Agricultural Research, and Nutrition. These areas, one may assume, are of interest to the largest numbers of our readers and should be pursued further.

The subjects in the middle and lower parts of the list in Table 1, from Education on down, represent more specialized economic sectors: they each have a following among readers, but less widely. (The subject of Women belongs in this group, it appears.) Finally, the broader or less focused topics--philosophical, anthropological, cultural/historical --attract fewer of our readers, though not a negligible number, and may be taken up occasionally. In addition, 43 people proposed subjects that we had not put on our list; but these are too diverse and numerous to summarize here. Answers to the final questions also suggest avenues of substantial reader interest.

The respondents to the questionnaire represent 40 different nationalities. Some of the larger country groups were: Indonesians, Pakistanis, Filipinos, Brazilians, Indians and Thais. Their occupations are almost as diverse, with 36 categories: university professors were the biggest group, followed by economists (largely in government) and librarians. But there were many other kinds of people who responded--bankers and financial managers, agriculturalists, engineers, town planners, businessmen, project managers and more narrowly defined specialists.

Table 1 - Results of January 1979 Questionnaire
(210 Responses)

Subject Areas of Interest	Number Interested*	Strongly Interested*
Strategies for Development	146	33
Planning; Project Appraisal	137	24
Agriculture	133	29
Village Technology	102	18
Employment Generation	101	17
Population Problems	101	10
Social Change	97	7
Marketing, Cooperatives	92	7
Science, New Technology	84	7
Agricultural Research	83	16
Energy Alternatives	81	10
Nutrition	77	14
Education	77	12
Irrigation, Water	73	10
Public Administration	73	9
Industry	73	6
Urbanization	72	6
Inflation	70	9
Health	70	7
Trade Policies	68	9
Foreign Investment	67	7
Women	67	7
Credit	66	5
Finance, Taxation	63	5
Entrepreneurship	62	9
Communications, Media	56	7
Foreign Exchange	56	7
Housing	55	3
Transportation	54	4
Resources: Metals, Forests, etc.	48	5
Anthropological Findings	47	1
Philosophical; Basic Needs, Human Rights, etc.	46	7
Cultural, Historical	38	0

Reader Preferences	Number Checked
More recent research results	129
More experiences in other countries	116
New thinking on old problems	97

Readers find the Digest:	
Very useful	111
Quite useful	73
Not useful, Occasionally useful	3

*"Number Interested" includes those with both single or double checks; "Strongly Interested" are those with double checks.

A second questionnaire was sent in the summer of 1979 to a smaller group of people, including those who had answered the first questionnaire plus some of the American and European subscribers and a random selection of others from the Third World. These questions dealt with various aspects of the Digest other than subject matter, such as the ways it can be used and its composition or presentation. Answers to these questions appear in Table 2; there were 155 responses.

As Editor of the Development Digest since 1968, I would like to say a few words to the many readers who have taken the trouble to send in answers to either or both of these questionnaires. I know that the Agency for International Development is most appreciative of your assistance, and I would like to add my expression of gratitude. Normally, I send my ideas around the world after guessing at what may be of interest to people in Asian, African and Latin American countries, but without any way of knowing whether or not I have guessed right. It is therefore good to hear the kind words that many of you have said; and critical statements can become more valuable for my thinking.

For example, I very often wonder whether certain English words to be used in the Digest will be difficult for the majority of my readers whose first language is not English; apparently this is not true, at least for most of those sending in their opinions. Similarly, the difficulty of understanding technical terms should not be too much of a deterrent to publishing new thinking in various fields (if one tries to explain them). Most respondents do not find the articles too "theoretical," but some do. On the question of long vs. short articles, and on the thoroughness of treatment of (fewer) subjects versus greater variety, there are clearly two schools of thought; but it appears that those who favor brevity and thoroughness are somewhat more numerous. (One reader pleaded for more humor and some cartoons--even though he recognized that the journal "is for professionals.") There is evidently an interest in book reviews; and some readers suggested the addition of book lists on a subject, or of more explanatory introductions. Some like the pictures, some don't; most respondents approve of the format, but some speak out against the appearance of the journal. There is general agreement on the desirability of articles by developing country authors, and on the value of case studies--reflected also in the commentary.

The comments by respondents are rather different from one another, but there seem to be a few common themes. Many readers find the Digest expanding their horizons, keeping them informed on countries other than their own and in fields they would not ordinarily look into. Some speak of a stimulus to ideas. In a number of cases, one copy of the journal will be passed around to quite a few people. While recognizing that many readers' opinions did not find their way into this survey, I find much that is useful to me, and I will attempt to provide more of what readers want. Perhaps one cannot keep everyone happy, but the attempt to do what one can is much encouraged by this display of interest.

Gordon Donald, Editor

Table 2: Responses to Second Questionnaire - Summer 1979
(155 Responses)

1. How does the Development Digest benefit you:
   a) Useful and relevant to your work? 137-yes/7-no.
      Have any proposed approaches worked effectively? 74-yes/18-no.
      Were they relevant to field conditions? 83-yes/25-no.
      Without practical application for you? 27-yes/62-no.
   b) Useful in putting developmental problems of your country into perspective? 109-yes/12-no.
      Learning about similar problems other countries are having? 140-yes/1-no.
   c) Useful in promoting professional communications? 119-yes/19-no.
   d) Serves educational purpose; keeps you apprised of latest developments? 142-yes/3-no.
   e) Useful in some other way? 80-yes/9-no. Please explain.

2. Do you read the Digest:
   a) Some of it? 111. All of it? 26. Skim through it? 53.
   b) As soon as you receive it? 99. Within 1 to 2 months? 54.
      Several months later? 6. Put it on a shelf, look at it occasionally as a reference document? 74.
   c) Would you subscribe if there was a minimal charge? 106-yes/29-no.

3. Do you pass it on to your colleagues? 117.
   How many read it? (Various numbers.)

4. Questions relating to English language:
   a) Do you find the English words used in the articles hard to understand? No-135. Sometimes-15. Often-0.
   b) Much of the new thinking in economics and social science is presented in technical terms. Editing can help, but cannot eliminate the problem. Would you prefer that Digest articles avoid such difficult subjects? 25-yes/87-no.
      Have fewer of them and more "readable" items? 54-yes/46-no.
      Even try harder to get the most advanced thinking? 73-yes/32-no.

5. Do you have suggestions for changes in content and format?
   a) Do you like the present format? 121-yes/20-no.
   b) Would you prefer a greater variety of subjects in one issue? 60-yes/80-no.
   c) Would you prefer a more thorough treatment of fewer subjects? 72-yes/55-no.
   d) Are the articles too theoretical? 32-yes/98-no.
      Should we present more case studies? 113-yes/26-no.
   e) Would you like to see: more book reviews? 87-yes/35-no.
      More pictures or graphs? 69-yes/43-no.
      More long articles? 39-yes/57-no.
      More short articles? 78-yes/33-no.
   f) Would you like to see more articles by developing country authors? 121-yes. Fewer? 7.

6. Have you or your friends had any problems obtaining copies of the Digest? 30-yes. Please explain.

7. Would you like to continue to receive the Digest? 155-yes/0-no.

FOOD SUPPLIES

LUNCH TIME AT A
DAY NURSERY SCHOOL
IN RANGOON, BURMA
(PHOTO: FAO, BY S. PUNNAG)

Overview of the World Food Supply Problem

Sterling Wortman and Ralph W. Cummings, Jr.

[The food supply problems of a world with fast growing populations can be effectively tackled with accelerated programs of intensified agriculture--if governments have the will to do so. The basic strategy, and some of the obstacles to overcome, are outlined.]

That the world food situation today is serious, even precarious, is well established. That world population was only 2,000 million in 1930, reached 3,000 million in 1960, and now stands at over 4,000 million is a fact. That man's numbers will reach 6,000 million or more during the next 25 years is a near certainty. That food deficits in many countries are reaching dangerous levels is well documented. That hundreds of millions of people in several scores of nations still live in abject poverty, plagued by hunger or malnutrition, is undeniable.

The complexity and magnitude of the task notwithstanding, for the first time in history it is now possible for many governments to act against both hunger and poverty. A decade ago--or probably even 5 years ago--success would not have been possible for most countries. In making this assertion, we are quite mindful of the words of U.S. President Truman in the now-famous "Point Four" of his 1949 inaugural address: "Fourth, we must embark on a bold new program for making the benefits of our scientific advances and industrial progress available for the improvement and growth of underdeveloped areas. More than half the people of the world are living in conditions approaching misery... For the first time

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in history, humanity possess the knowledge and the skill to relieve the suffering of these people." One may ask, then, why it is any more realistic to claim today that governments could successfully attack hunger and poverty than it was three decades ago? There are good reasons, and a strategy for action is emerging. But to understand the strategy, one must understand the nature of the problem.

Three Eras of Agricultural Development

Over thousands of years, people have practiced subsistence or traditional agriculture. First, there were the hunters and gatherers of food; then, as groups took up sedentary farming, there began the long and slow process of the evolution of countless systems of crop and animal production, many of which persist today. The productivity of such traditional farming systems is largely limited by fertility of the soil and characteristics of climate. As populations have burgeoned, particularly in recent decades, landholdings have been divided and subdivided among heirs, so that in many of the more populous nations farms are tiny by North American standards; for example, in parts of Indonesia, the average holding is less than one-half hectare. The evolution, over thousands of years, of traditional farming systems--which the great bulk of the world's farmers still use today--constitutes a first era of agricultural development.

A second era of agricultural development--science-based and industry-supported--has largely occurred in this century. During the past 75 years we have witnessed an agricultural revolution in which the now-industrial nations pioneered and excelled. That revolution has been characterized by the creation, by genetic manipulation, of more efficient crop varieties and animal strains; the development and use of chemical fertilizers and of science-based means to control diseases and insect pests; the development of agribusiness; the expansion of road networks, power grids, and use of farm machinery; the development of means of mass communication of information; and of course the ever greater skill of farm entrepreneurs in intensified agriculture. Rising economic demand for goods and services has spurred this remarkable era of ever higher yields per unit of area, time, or investment. Science and industry have provided the building blocks for today's advanced agricultural systems, but let us not forget the role of the farm producer in the equally sophisticated task of putting together for the individual farm all the components of productive and profitable systems.

We are now entering a third era, the era of accelerated, forced-pace agricultural and rural development efforts. Scores of nations in serious difficulty are looking for ways to increase food production and incomes and raise living standards among the rural masses, not in 50 or 75 years but in 10 or 15. The incentives for action

are becoming clear: they involve urgent matters of political stability and national security, as well as economics.

First, government leaders are increasingly aware that, unless they take steps to develop their rural areas through widespread involvement of the rural poor, they will likely face unrest, violence, even revolution. With advances in mass communication and transportation, long-neglected people are recognizing that a relatively small fraction of the citizenry is enjoying the comforts of life. Yet they see little hope for themselves or for their children. They are responsive to any ideology which will offer to them those things they hold most important: food, clothing, health care, education, security--and hope.

Second, with the 1973-74 disappearance of large crop surpluses in the U.S. and other countries and the resulting high prices, governments have learned that they can no longer count on continuing access to the cheap sources of food which enabled them to keep food costs low in their urban areas while neglect of their agricultural areas and people persisted. High food costs in international markets, which require substantial outlays of scarce foreign exchange, have for the first time forced some governments, for security reasons, to worry about increasing the productivity of their long-neglected small farms.

Third, governments are learning they can substantially expand their domestic markets for products of urban industry by extending science-based, market-oriented agricultural production systems among great masses of rural people. As farm families have access to greater disposable income through increased agricultural profits, they become purchasers of goods and services. Employment rises not only on farms but especially in rural trade centers.

This third era of agricultural development must involve concerted efforts to move into the countryside more aggressively and systematically with roads and power systems, with supply of inputs and arrangements for the marketing of agricultural products. Moreover, scientists must work directly in rural areas to create the more highly productive, more profitable farming systems which will contribute to the primary ingredient for rural development: increased income for large numbers of farm families.

Decreased rates of population growth must be achieved whereever necessary; otherwise there can be no long-term solution to the food-poverty-population problem. Economic development should contribute to the lowering of population growth rates, and successful efforts to get agricultural production up in the developing countries is central to economic development. Agricultural development efforts buy time for slowing population growth, and that time must be used wisely.

The task ahead. We must not underestimate either the complexity of the task ahead or the dedication to the efforts required. In mid-1975 the world population was about 4,000 million. About 2,000 million people will be added by the year 2000, about two-thirds of them in already heavily populated nations.

Before World War II, Latin America, Africa, and Asia were net exporters of grain--the staple food of most populations. By 1950 they had become net importers of about 5 million tons a year. By 1960 their net deficit had climbed to 19 million tons and by 1973 to around 47 million tons. Their combined deficit for 1976 was about 60 million tons. Unless the trend in production in developing market-economy countries improves, world production of cereals by 1985 is projected to fall short of demand by 100-200 million tons.

It is important to understand the nature and diversity of the countries where the problems of hunger and poverty are or will likely become most severe.

- Most developing countries are extremely poor. While in 1975 the per person gross national product (GNP) was US$7,060 in the U.S., $6,650 in Canada, and $2,620 in the U.S.S.R., there were 61 countries with GNP below $500 and 36 with GNPs of less than $250. Income levels among the masses of the rural people are well below the average in each of those countries.

- Many nations are small. In 1976 there were 161 nations or geopolitical entities with substantial local autonomy, and 78 had populations of 5 million or less; of these, 34 had fewer than 1 million.

- Many nations are newly independent. Of the 43 nations considered by the United Nations as "least developed" or "most seriously affected" by the recent economic crisis, 36 have become independent since 1945 and 29 of these since 1960.

The newer, smaller, poorer countries face most of the problems of the larger, older, developing countries and, in addition, they have severe problems in gaining access to trade, financial and technical assistance, and knowledge.

As colonial systems weakened, the cutting of political ties with major industrial nations was frequently accompanied by a loss of assured markets for exports or assured sources of needed imports. New trade relationships had to be worked out with the industrialized countries. Foreign commercial investment in local agricultural enterprises has generally become less attractive because of local opposi-

tion to management of domestic enterprises by foreign personnel. Small nations, whether newly independent or not, cannot expect to have the full range of scientific and other professional services required in all fields important to their development. They must usually rely heavily on external help. Each small entity finds itself jostling with a great number of other small entities for technical and financial assistance, and must attempt to fit the potential assistance to their particular needs.

Most of the newly independent nations were left with limited scientific or managerial capability to improve food production. In general, the colonial powers had done much to develop export crops and animal species destined for sale abroad. While the developing nations are dotted with centers for research on coffee, cacao, rubber, or jute, until a few years ago one could find few centers for work on wheat, maize, rice, the food legumes, the root crops, the vegetables, or other food crops. The basic food crops were neglected. It should be recalled, however, that in 1930 the world population was only 2,000 million, or half that of 1975; there was not the same population pressure on the land that exists today in most countries, and, until a few decades ago, the increasing food needs of those countries could be met by cultivating more land. But that option is disappearing--or is already gone in some areas.

In the governments of most low-income countries, the persons in authority are military men, lawyers, businessmen, physicians, engineers, economists, or religious leaders. Few understand agriculture or the technology and science which underlie it. Given the complexity and urgency of the task ahead, one can rightly ask, Is there any hope? The answer is yes, the world does have the capabilities, and the reasons why need to be understood. To a large degree, these capabilities have come into being during the past decade.

The basis for hope. The basis for hope rests on several factors. The world's leaders are becoming more aware of the problem. The physical resource base, particularly arable land and water, can permit a substantial increase in the intensity of cropping in most countries. Steps have been taken to begin to produce the crop strains and related technologies required to increase agricultural production in the tropics and subtropics, where most developing countries are. Fertilizers have become available in sufficient quantities and at low enough cost to allow their use to be extended to the food crops in the low-income countries. International assistance mechanisms exist which can provide funds and technical counsel for development efforts. Most of these efforts can be financed on a loan basis because investment in agriculture is at least as profitable as investment in airlines, manufacturing, or housing. It has been demonstrated that the developing countries can, if they will, successfully promote agricultural and rural development. It has been shown that the

farmers will shift to new systems if these prove sufficiently productive and profitable. The will of governments to take action is growing. These factors, combined with the tremendous scope for increasing food-crop production in most developing countries, represent the basis for the statement that for the first time in history we now have an opportunity to deal effectively with the problem.

The Strategy

A prime concern of the government of any nation, if that government is to remain in power, is provision of the fundamental requirements of its citizenry. Among those requirements are security, an adequate food supply, and the means for an improved standard of living. Central to progress in all poorer agrarian countries is increased productivity and prosperity of the rural areas.

In agrarian nations it is the many farmers with tiny landholdings, often in remote areas, plus those people on the coasts who depend upon near-shore fisheries and aquaculture for a livelihood, who produce the bulk of the food supplies. Usually, raising the productivity and income of these poor rural dwellers requires new high-yielding, science-based crop and animal production systems tailored to the unique combination of soil, climatic, biological and economic conditions of each locality. In short, the agricultural revolution which has undergirded the economic advances of the industrialized nations must be extended quickly and systematically to all areas of the poorer agrarian countries.

Two sides of the food problem. Increasing farm production to meet the needs of the rural family is important. But one objective of agricultural development must be to allow individual families to produce a surplus for sale, so that the total output of a locality exceeds total local requirements and permits sales in urban centers, other rural regions, or in international markets. Inputs required for higher productivity must be purchased and markets for products must be established. Thus, traditional farmers must be brought into the market economy. In this way they will become purchasers of larger amounts of goods and services, contributing not only to the vitality of enterprises in their rural trade centers, but also to the expansion of domestic markets for products of urban industry.

As increasing numbers of traditional or subsistence farms are brought into the market economy, they will require a range of services similar to those of other small businesses. Many of these services--input supply and marketing--can often be supplied most efficiently by private enterprise. Some, including development of improved farming systems and development of nonhybrid crop varieties, must be provided by government since private industry usually cannot recapture investments in such activities.

When we speak of the world food problem we often tend to oversimplify it. The immediate problem to be attacked is low agricultural productivity and lack of employment of great masses of rural people. Clearly there are two sides to the food problem: one is to increase production; the second is to create purchasing power among the hungry. The effort to increase crop and animal production on the hundreds of millions of family farms around the world gets at both sides of the equation. It is the only approach which does.

Targeting on the small farmer. Agricultural development is commonly organized to achieve local or nationwide gains in the production of particular commodities. Goals are normally expressed in terms of tonnages to be achieved or hectares to be covered in a given time, and these may be appropriate under some circumstances. But if such are the goals, agencies cannot be blamed for concentrating on the better agricultural regions, or working with large farmers, because those are the quickest and least expensive ways to achieve output or area-coverage goals. Until recently, there have been few direct attempts to help large numbers of small farmers to increase productivity and incomes, with numbers of farmers to be benefited as the goal. If such farmer-participation goals are not clearly stated, agencies will not undertake the difficult task of working with numerous small farmers, and they will continue to be by-passed. But, if efforts are aimed at the small farmers, all farmers will benefit, for the educated farm operators with large holdings are generally quick to adopt any advances which increase farm profitability. By casting the development net to involve small farmers, most farmers will gain.

Meeting requirements for farmer participation. Experience in many countries demonstrates that farmers will shift to more productive and profitable agricultural systems if they can. This applies to the relatively uneducated producers with small holdings as well as to those well-educated entrepreneurs with large farms. To enable farmers to participate in the market economy, a number of requirements must be met simultaneously. First, productive and profitable combinations of technology must be available. Second, the farmer must be instructed in their use. Third, necessary inputs (seed, fertilizer, pesticides, vaccines and feed supplements for animals) and credit must be available when and where the farmer needs them and at a price that allows a profit. Fourth, there must be markets for farm produce.

If any of these four requirements is lacking, farmers will not switch to more productive practices. Government efforts in the past have often centered on individual components such as supply of credit, or of seed, or extension services, with disappointing production results. Such failures usually stem from remaining weaknesses in the system, quite often in the technological component, or from markets or supply points that are too distant from farms, or from prices to farmers that are too low to allow a reasonable profit. Usually the fault for

failure is not the farmer's; it lies in the design or execution of programs, including policy components.

Agrarian transformation. In many countries the institutional structure of agriculture, particularly the land tenure situation, is not conducive to developing a productive agriculture built on small farms, individually or collectively managed. Land tenure largely determines who benefits from increases in productivity. It influences the amount of the farmer's production by determining when he gets access to new technologies including the necessary inputs, and how much of the production he is able to retain. It shapes the distribution of employment opportunities in the agricultural sector. It influences the rural person's income and status in the community.

In some countries, governments are distributing state-held lands. And some individuals and corporations are beginning to divest themselves of extensive landholdings--some doing so, they say, while they still can. In other countries, however, land reform may be required. Distribution of land in itself will not lead to higher productivity unless the four requirements listed earlier also are met. Often these conditions do not exist and results of land reform programs remain disappointing.

Programs to increase the productivity and profitability of agriculture need not wait for land reform; many subsistence farms, or those with limited sales, could, through provision of necessary services (including supply of technology), produce larger surpluses than they do now--and without undue delay. However, in the absense of effective agrarian reform the results will never reach full potential in terms of either production or income distribution. This concept of a high density of farms owned and operated by families is broad enough to embrace independent farm units in a free-enterprise system, farm federations, cooperatives, and even the communes of the People's Republic of China.

Approaches to accelerated agricultural development. Development of agriculture and rural areas has taken many forms. Most offer some benefits and most have significant limitations. None alone is adequate.

New institutions have been established, and existing ones--such as planning agencies, research and extension organizations, universities or colleges and schools of agriculture, credit banks, supply and marketing organizations, farmer groups (including cooperatives)--have been strengthened with varying degrees of success. All are important, and such efforts must continue. If national progress is to be greatly accelerated, however, such institutions, and others public and private, must become directly involved in development programs, making concerted efforts in each farming district. Their contributions to development, rather than their own growth and prosperity as institutions, must be the measure of success. This will often require substantial modifica-

tions in their goals, their organizational structures, the qualifications of their staff, the arrangements for integration of their efforts, and their reward systems.

The most dramatic advances of recent decades have involved commodity production programs. In the developing countries there have been many instances of success--particularly with plantation or export crops --involving synchronization of production, research, and marketing. More recently there have been successes with basic food crops such as wheat in India, Mexico, Pakistan, and Turkey; rice in Colombia, India, Pakistan, and the Philippines; and maize in Kenya.

Another tactic now being widely employed is defined-area campaigns to achieve widespread gains in the productivity and incomes of rural people. In a particular locality this approach may be limited to intensive efforts to increase the productivity and profitability of one or a few commodities, or it may encompass comprehensive attempts to improve agriculture, along with education, housing, and health care, as well as to provide nonfarm sources of employment, through "integrated development." Defined-area development builds understanding of a rural community--its resources, the aspirations and activities of the people, its problems, and its potentials--and permits subsequent changes in the community to be measured. The ability of public and private agencies to cooperate can be determined, and weaknesses can be corrected. Innovations can be tested, and errors minimized, prior to wider-scale application. Moreover, such defined-area programs allow staff, through work with farmers and others, to become skilled in the solution of farm-level problems.

Successful efforts to force the pace of agricultural development must involve simultaneous provision of all necessary services, locality by locality--roads, markets, prices, input supply, and research. This will require reorientation and synchronization of the activities of diverse government agencies and of private industries, and decentralization of marketing and supply systems. To be effective at local levels, synchronization or coordination must occur at every level of government, including the top levels of ministries. A number of nations are seeking mechanisms by which to facilitate such synchronization.

The most comprehensive and desirable approach to accelerated development is a combination of commodity-oriented and defined-area efforts, supplemented by the strengthening of relevant institutions and attention to synchronization of the many services required for the success of either approach. It is important to note that the most effective way to improve institutions is to involve them in purposeful, fast-moving development efforts. The alternative of building institutions with the expectation that somehow they will later contribute to rapid development generally has been disappointing. While staff members may be well educated, they will lack the competence which only prior experience in development programs can provide.

Before national, comprehensive, accelerated agricultural development programs begin, long-term (15- to 20-year) goals should be established. This will provide the framework for shorter-term (say, 5-year) plans. At best, agricultural development is slow and involves large numbers of biological and social variables. It is important that such efforts be made in the right direction. Long-term goals cannot be precise, for no one can foresee all problems and potentials with clarity. Much planning must be based on the judgment of knowledgeable individuals, bolstered by experimental evidence to the extent possible. This will require the joint efforts of political leaders, planners, businessmen, industrialists, and persons of vision in the various agricultural specialities.

Three nonsolutions. Three often-mentioned "solutions" are important but do not address the basic causes of the world food problem. First, increased production in North America and by surplus-producers elsewhere will not contribute directly to the solution of the world food problem. Poor countries can ill afford to pay for food imports. Moreover, their deficits are growing so fast that neither North America nor others can possibly afford to provide free or subsidized food on the scale which soon will be required if developing countries are unable to speed agricultural development.

Second, large-scale mechanized crop production in most of the densely populated developing countries is not a practical solution to their food problem so long as the hungry have no way of getting more money to buy food. Moreover, large-scale mechanized farming generally is less productive per hectare than is "gardening," which can be practiced on small farms with abundant labor supply. Mechanized agricultural systems raise productivity per man-year and are highly productive otherwise, but most poor countries need labor-intensive systems.

Third, production of synthetic foods, single-cell protein, or other manufactured food products is not an answer to the world food problem. Here again the hungry have no means by which to pay for food of any kind, and such items are too expensive for free distribution on the scale which would be required.

Obstacles to overcome. One might wish that accelerated agricultural development were a simple matter that men of vision, authority, and good will could with confidence set in motion at once. Sometimes, unusual opportunities for large-scale achievement do occur, as when India launched the High-Yielding Varieties Program in 1964, when the Philippines started its "Masagana 99" campaign, or when Turkey intensified wheat production in her coastal areas. Similar opportunities no doubt will continue to arise, but such instances will be insufficient. Rather, governments must establish long-range national goals and create mechanisms and conditions for broad and rapid change in desired directions. They must place responsibility in the hands of

individuals prepared to achieve ambitious targets, and then sustain long-term efforts. And international assistance agencies must support enlightened governments in such endeavors.

The wide range of barriers to the acceleration so urgently needed in so many countries must be surmounted.

- Not all national governments have the will to invest in agricultural development. The high financial returns to investment in agriculture often are not made known to national authorities in language they understand. Moreover, food aid--food sold at concessional rates or donated--if often used for continuing support of governments which neglect their rural problems.

- Development efforts are often fragmented. Responsibilities are divided among ministries or among departments within ministries. Capital and technical assistance is often provided through a series of scattered and uncoordinated projects.

- Individuals in developing countries who are attracted to agricultural development programs often are poorly trained and do not have farm-level experience.

- Too few of the technical assistance personnel from the developed countries are experienced in planning and implementing programs to accelerate agricultural development.

- Conservatism predominates among scientists in both the developing and developed countries. Disciplinary rather than problem-solving orientations persist. Laboratory work is of higher prestige than farm-level research and action programs. In-service training receives minor attention.

- The literature on agricultural development is often only remotely relevant to the problems that program practitioners must face.

A new level of effort required. The task ahead is vast and complex. It requires concerted work by individuals of considerable scientific and managerial ability--at least equivalent to those of the research and development efforts undergirding space programs. The creation of new crop varieties and associated cropping systems will require, both at international centers and in national research programs, capable plant breeders, agronomists, soil specialists, plant pathologists, entomologists, animal scientists, biochemists, and economists, to name a few. They must tailor the crops and cropping

systems to the ecological, climatic, and soil conditions of every season of every region of every country.

Decentralized systems must be devised to supply the inputs, fertilizers, pesticides, water, and credit to large numbers of farmers at low cost, and these must be established in a hurry. There must be improved marketing systems, including arrangements for the purchase, transport, processing, and sale of farm products. Industry must be involved in preservation, storage, supply of quality seed, and many other aspects of modern market-oriented agricultural systems. In each country attention must be given to means of involving every relevant institution--public and private--in direct efforts to lift productivity, incomes, and living standards in rural areas. This calls for individuals who understand how national systems can be synchronized to achieve maximum progress at lowest cost.

The old idea that the U.S. or other countries could transfer agricultural know-how to other countries wholesale is a myth. Much technology, of course, is transferable. However, the idea that industrial countries could simply send farmers or extension specialists to the poor countries to show them how to farm, and thereby raise yields, has now been set aside. Such farmers and extension agents generally are highly competent people, but most of the temperate-climate farming practices in which they are skilled simply will not work in developing countries. The reason is that such prerequisites as efficient crop varieties, disease and insect-control practices, and means of preventing animal diseases are not yet available. The sophistication of the efforts required must not be underestimated.

Every government must be responsible for the food supply of its own people and for the development of its rural areas. Only the individual government can determine amounts to be imported or produced locally. Only the government can set the policies, strengthen the institutions, and reach the farmers and other rural people. Outside agencies can assist, as they must wherever governments are committed to rural progress and outside help is welcomed, but that is all they can do.

The challenge of increased food production is urgent for all. But production of food in itself is not enough. The hungry have no money, and until their purchasing power is increased, giving them access to food as well as other necessities, there can be no solution to the world food problem.

In discussing strategies for advances in rural areas, one must remember that increasing agricultural productivity and prosperity in the countryside is not a panacea for all the economic and social problems of a nation. But rural progress will be crucial to the general development of most nations. Those responsible nationally

for establishing goals, allocating resources, and implementing programs of work must achieve a balance among the many competing demands upon national resources. Our appeal is not for exclusive attention to agriculture, for that would be naive; rather, it is for greater investment in agriculture and other means of increasing the productivity of rural dwellers, and for substantially improved effectiveness of efforts already under way. For the first time in history the world now appears to have the capability of dealing effectively with the difficult problems of hunger and poverty. The future of any nation is clearly entwined with that of nations elsewhere. Clearly the wisdom of choices in the immediate future will markedly affect the nature of the world in which the next generations will live. And, while the food-poverty-population problem is massive and complex and will be extremely difficult and time-consuming to resolve, the existence of new capabilities provides a magnificent opportunity, perhaps a fleeting one, to deal with it effectively--if governments have the wisdom and the will to act.

Rapid Growth in Food Production in 16 Developing Countries, 1961-76

Kenneth L. Bachman and Leonardo A. Paulino

[An examination of the countries which have shown the most rapid and consistent increases in production of staple foods between 1961 and 1976 indicates a variety of different reasons for their success. This article provides a general review of the sources of their growth.]

Food production in the developing countries with market economies (DMEs) did not increase satisfactorily during the past 15 years. For all 94 DMEs, total food output during 1961-76 expanded at the rate of 2.6 percent a year, barely keeping abreast of overall population growth, and failing to attain levels that could also meet increases in demand due to the rising incomes and nutritional requirements of the populations of these countries.

In 53 of these countries the growth in staple food production fell behind population growth, representing a worsening of the food problem. In 38 of those 53 countries, the average annual increase in food production was less than 1 percent, compared with their 2.4 percent a year growth of population. On the other hand, of the 41 DMEs where food production expanded faster than population, 24 achieved relatively high production growth rates of 3.3 percent or more in 1961-76. The annual rate of growth of staple food output in these rapid-growth countries averaged 3.9 percent, which well exceeds their population growth of 3.0 percent a year. The average annual growth rates among these country groups were as follows:

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	Number of Countries	Food Production	Population	Per Capita Food Production
Rapid-growth	24	3.9%	3.0%	0.9%
Medium-growth	32	2.7	2.5	0.2
Slow-growth	38	0.9	2.4	-1.5
All DMEs	94	2.6	2.6	0.0

Of the 24 rapid-growth countries, 16 were selected for this study: Brazil, Colombia, El Salvador, Ghana, Iran, the Ivory Coast, Malaysia, Mexico, Morocco, Pakistan, the Philippines, Sri Lanka, the Sudan, Thailand, and Tunisia. These represented 99 percent of staple food production and 97 percent of population of the group of 24 in 1976. This study focuses on the sources of growth and changes in the pattern of food production in these 16 countries. Spread over the world's four geographical regions, these countries exhibit wide differences in natural and demographic features and in patterns of agricultural and economic development.

Most of these rapid-growth countries belong to the middle- and high-income groups of DMEs. Only three (Pakistan, Sri Lanka, and the Sudan) had incomes below US $300 per capita gross national product (GNP) in 1976. Of the other 13 countries, Brazil, Iran, and Mexico had a per capita GNP exceeding US $1,000. In these three countries, agriculture accounted for 10 percent or less of the 1976 gross domestic product (GNP), whereas in all but two of the remaining countries it accounted for 25 percent or more. Per capita income rose 2 percent or more per year in most of the rapid-growth countries during the 1961-76 period.

Trends in Rapid-Growth Countries

Growth in population and income per capita significantly increased the demand for staple foods in the study countries. The domestic use of staple foods in these countries increased by 61 percent between 1961-65 and 1974-76, or roughly 1 percent per capita a year. Per capita dietary energy consumption also generally improved at much faster rates than in other developing countries. In seven of the countries, per capita calorie consumption also rose at least 1 percent per year during 1961-76. In Mexico and Paraguay where it rose less than 1 percent, the growth in per capita calorie consumption equalled or exceeded that of per capita food production. In contrast, little improvement occurred in the dietary energy consumption in other DME countries outside the rapid-growth group.

The rapidly increasing demand for livestock and poultry feed in several rapid-growth DMEs greatly stimulated staple food production, especially in the Latin American countries and in the high-income countries in the North Africa/Middle East region. Increases in food

consumption and production appeared to have mutually reinforced each other in several of these countries. Rising income has led to increased consumption of livestock and poultry products, which has in turn stimulated increases in the output of maize, sorghum, and cassava for livestock feed, i.e., for conversion into these higher-quality foods.

It appears that the traditional net exporters to DMEs need not worry about losing their markets as the result of an expansion of food production in the rapid-growth countries. Although the proportion of consumption coming from domestic production in these countries increased, the volume of their net imports of staple food also increased (the net increase in imports was even stronger among the slower growing DMEs). Net staple food imports per year in these countries rose 2 1/3 times between 1961-65 and 1974-76; actual imports levels grew by 87 percent while exports increased by 53 percent. The expansion of both exports and imports reflects on one hand the increased production capacity for particular crops in these countries, and on the other, the rapidly increasing demand for food staples generated by population growth and improved income levels. The absolute and relative changes in the average yearly trade levels for staple foods between 1961-65 and 1974-76 were:

	(1,000 metric tons)	(percent)
Imports	+6,510	+86.5
Exports	+2,337	+53.2
Net Imports	+4,173	+133.0

The fast growth of food production in the study countries resulted from significant increases in a wide variety of staple food crops. Maize contributed 28 percent, wheat 24 percent, and rice 19 percent to the total increase in food output; sorghum contributed 10 percent, and the share of the rest of the cereals was 3 percent. Increases in root crop output, primarily cassava, accounted for 10 percent of the total increment in staple food crop production. (In the slow-growth and other DME countries, wheat and rice contributed nearly two-thirds of the increase in staple food production, with maize contributing less than 15 percent.)

Wheat and sorghum production increased in importance in the rapid-growth countries in the 1961-76 period, whereas maize maintained its relative importance. Although rice has made a large contribution to the growth of food output in these countries, its relative share of total production has declined slightly. Changes in commodity demands have been important in these shifts of production growth patterns. The shares of the important cereal crops in total food output of the 16 countries in 1961-65 and 1974-76 were:

	1961-65	1974-76
	(percent)	
Maize	29	29
Rice	24	22
Wheat	15	19
Sorghum	3	6
All Cereals	77	80

Maize accounted for more than half of food production growth in Brazil, El Salvador, and Paraguay, whereas wheat was the dominant contributor to food output in Iran, Pakistan, and Tunisia. Rice, the most important food staple in Asia, contributed 88 percent of the increase in Malaysia and 50 percent in the Philippines. Sorghum accounted for nearly half the increase in Mexico and, together with groundnuts, represented the dominant source of increased production in the Sudan. Barley represented 53 percent of the food increase in Morocco. In the Ivory Coast, root crops contributed more than half of the growth of staple food output.

Sources of Growth

Rapid growth in food production falls into three patterns based on the relative contributions of area expansion and increased output per hectare. The latter was the dominant factor in Colombia, El Salvador, Mexico, Morocco, Pakistan, and Tunisia, contributing from 63 percent to 93 percent of production growth. In the Ivory Coast, Malaysia, the Philippines, and Thailand, the contributions of the two factors were nearly equal. Area expansion contributed 72 percent or more of the growth of food output in Brazil, Chana, Iran, Paraguay, Sri Lanka, and the Sudan. And increases in crop area entirely sustained the rapid growth of staple food production in Ghana, Paraguay, and the Sudan, where declines in output per hectare occurred.

Shifts in crop area patterns toward higher- or lower-yielding crops (in tonnage per hectare) significantly affected the total output per hectare of staple food crops in several of the study countries. Except for the Sudan, all data for selected rapid-growth countries reflected increases in output per hectare when the effects of changes in crop area pattern are excluded. Relatively more rapid expansion in the area of sorghum in Mexico, sorghum and root crops in Colombia, and root crops and maize in Thailand has increased the average annual rate of growth in output per hectare by around 1 percent a year. In Pakistan, the faster expansion of rice area relative to wheat area contributed 0.5 percent to the growth in output per hectare. In the rapid-growth countries where increases in food output came largely from rapid area expansion, however, significant shifts from relatively high-yielding root crops into cereals reduced the annual growth rate

TABLE 1

Average annual growth rates of production, area, and output per hectare of total staple food crops in selected rapid-growth countries classified according to main sources of growth, 1961-76 [a/]

Country by Category	Production	Area	Output Per Hectare
		(percent)	
Largely increased output per hectare			
Colombia	3.8	0.7	3.1
El Salvador	5.7	2.1	3.6
Mexico	3.8	0.8	3.0
Morocco	3.7	0.6	3.1
Pakistan	4.7	1.0	3.7
Tunisia	5.7	0.4	5.3
Increased area and output per hectare			
Ivory Coast	3.4	1.9	1.5
Malaysia	4.9	2.9	2.0
Philippines	3.9	1.8	2.1
Thailand	4.2	2.2	2.0
Largely increased area			
Brazil	3.5	3.4	0.1
Ghana	3.5	3.7	−0.2
Iran	4.3	3.1	1.2
Paraguay	3.6	5.3	−1.7
Sri Lanka	3.7	3.4	0.3
Sudan	4.4	5.8	−1.4
Selected rapid-growth	3.9	2.2	1.7
Other DMEs	2.2	0.7	1.5
Selected slow-growth	1.1	0.8	0.3
All DMEs	2.6	1.1	1.5

Sources: Food and Agriculture Organization of the United Nations, "Production Yearbook Tape, 1975," Rome, 1975; and Food and Agriculture Organization of the United Nations, "Production Yearbook Tape, 1976," Rome, 1976.

a/ Excluding plantains.

of output per hectare of staple food crops. Changes in the crop area pattern of staple food crops did not seem to affect the output per hectare in Morocco, the Ivory Coast, and the Sudan.

TABLE 2

Average annual growth rates of production, area, and output per hectare of cereal crops in selected rapid-growth countries classified according to main sources of growth, 1961-76 [a]

Country by Category	Wheat			Rice			Maize			Sorghum			Total Cereals [c]		
	Production	Area	Output Per Hectare	Production	Area	Output Per Hectare	Production	Area	Output Per Hectare	Production	Area	Output Per Hectare	Production	Area	Output Per Hectare
	(percent)														
Largely increased output per hectare															
Colombia	-7.5	-10.4	2.9	7.7	1.2	6.5	-0.2	-1.9	1.7	27.1	26.5	0.6	2.6	0.3	2.9
El Salvador	...	...	...	4.5	0.7	3.8	6.0	1.5	4.5	4.8	2.4	2.4	5.6	1.8	3.8
Mexico	4.3	-0.6	4.9	3.2	1.4	1.8	1.7	0.0	1.7	17.5	16.0	1.5	3.9	1.0	2.9
Morocco	2.8	0.5	2.3	...	...	...	0.9	-0.9	1.8	...	...	...	3.3 [d]	0.4 [d]	2.9 [d]
Pakistan	5.8	1.7	4.1	6.6	2.1	4.5	3.2	2.1	1.1	1.6	-0.3	1.9	5.2	1.3	3.9
Tunisia	5.9	1.2	4.7	...	...	...	...	...	...	...	...	...	5.5	0.2	5.3
Increased area and output per hectare															
Ivory Coast	...	...	...	5.5	2.4	3.1	1.1	3.7	-2.6	6.8	5.0	1.8	3.6	2.1	1.5
Malaysia	...	...	...	5.0	3.1	1.9	7.0	0.5	6.5	...	...	...	5.0	3.1	1.9
Philippines	...	...	...	3.4	0.8	2.6	5.5	3.4	2.1	...	...	...	4.1	1.9	2.2
Thailand	...	...	...	2.1	1.0	1.1	10.2	9.1	1.1	13.9 [b]	15.0 [b]	-1.1 [b]	3.4	1.8	1.6
Largely increased area															
Brazil	12.4	10.8	1.6	2.2	3.0	-0.8	4.2	2.8	1.4	17.3	7.9	9.4	4.4	3.7	0.7
Ghana	...	...	...	6.1	7.3	-1.2	5.7	4.8	0.9	2.8	2.4	0.4	4.9	4.6	0.3
Iran	4.8	3.4	1.4	4.4	2.7	1.7	...	...	...	...	...	...	4.4	3.2	1.2
Paraguay	9.8	11.9	-2.1	9.0	10.7	-1.7	6.4	6.5	-0.1	...	...	...	6.8	7.2	-0.4
Sri Lanka	...	...	...	2.8	1.9	0.9	7.9	8.4	-0.5	...	...	...	2.9	2.1	0.8
Sudan	16.2	18.4	-2.2	...	...	...	7.7	6.6	1.1	2.9	4.2	-1.3	3.6	5.5	-1.9
Selected rapid-growth	5.5	2.8	2.7	3.1	1.7	1.4	3.7	2.0	1.7	9.0	5.4	3.6	4.1	2.3	1.8
Other DMEs	4.2	1.7	2.5	2.5	0.9	1.6	2.4	1.2	1.2	1.9	0.1	1.8	2.5	0.8	1.7
Selected slow-growth	1.9	0.7	1.2	1.5	1.0	0.5	1.4	1.0	0.4	0.0	0.8	-0.8	1.1	0.7	0.4
All DMEs	4.5	2.0	2.5	2.6	1.1	1.5	3.0	1.6	1.4	3.0	0.7	2.3	2.9	1.1	1.8

Source: Food and Agriculture Organization of the United Nations, "Production Yearbook Tape, 1975," Rome, 1975; and Food and Agriculture Organization of the United Nations, "Production Yearbook Tape, 1976," Rome, 1976.

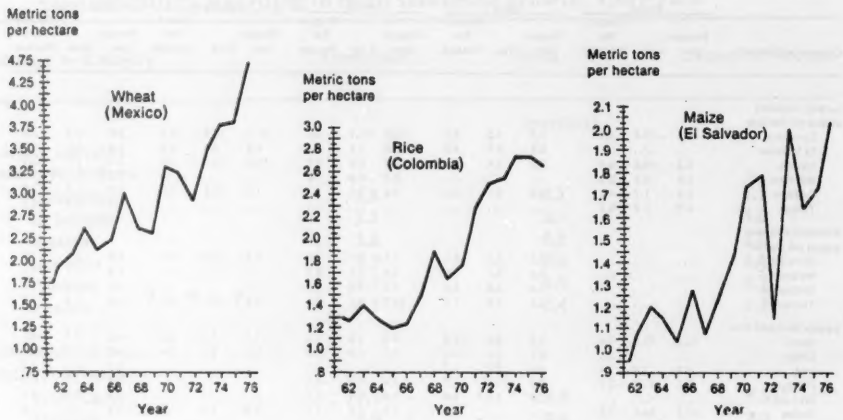
[a] Includes crops in countries where the 1976 production was more than 1 percent of total major staple food production.
[b] For the period 1964-76.
[c] Includes all cereals
[d] In Morocco, the growth rates of production, area, and output per hectare of barley were 4.6, 0.8, and 3.8 respectively.

Changes in production inputs. The extent to which assessments can be made of the influence of increased use of agricultural production inputs on the growth in output per hectare and area of staple food crops is limited by the lack of data on the use of these inputs by crop. Available international data on fertilizer use, irrigation, agricultural employment, and tractor use are in totals for agriculture as a whole. The significance of increases in tractor numbers also varies because of the large variations in the size of tractors used in the various countries. Nevertheless, analysis of the increases in the use of agricultural production inputs can provide some important additional indications of how the rapid-growth countries achieved the increases in crop yields and overall output per hectare.

Table 3 compares the increases between 1961-65 and 1975 in fertilizer consumption per hectare of gross cropped area, and the percentage of arable land under irrigation, with the changes in both

FIGURE 1

YIELDS OF WHEAT, RICE, AND MAIZE IN LEADING COUNTRIES, 1961-76



the trend and the "hypothetical" output per hectare of food crops with cropping patterns unchanged. In addition, the results of a regression predicting increases in the hypothetical output per hectare resulting from given changes in fertilizer use and irrigation are shown in the last column. The effects of a shift to more extensive or intensive staple food crops are seen in a comparison of column 3 with column 4, and were considerable in some countries--notably Paraguay, Ghana, Colombia, Thailand and Mexico.

Although overall increases in fertilizer use and irrigation were closely associated with yield increases of staple food crops in many countries, the association was poor in some cases. In Tunisia, Brazil, and the Sudan other factors appear to obscure the changes in fertilizer use and irrigation that are associated with variations in the hypothetical output per hectare. If these countries are omitted, changes in these two factors would account for 82 percent of the changes in the hypothetical output per hectare (columns 4 and 5).

Other factors, specifically high-yielding varieties and, to a lesser extent, mechanization have also been very important in particular countries. Information on the use of high-yielding varieties of wheat and rice are shown in Table 4. Increases in staple food crop area in the rapid-growth countries were also associated with increases

TABLE 3

CHANGES IN FERTILIZER USE PER HECTARE, IRRIGATED AREA, AND OUTPUT PER HECTARE OF STAPLE FOOD CROPS IN THE SELECTED RAPID-GROWTH COUNTRIES, 1961-65 to 1974-76[a/]

Country	Fertilizer Use Per Hectare of Total Crop Area (kilograms)	Portion of Arable Land Under Irrigation (percent)	Staple Food Output per Hectare (kilograms)		
			Actual[c/]	Hypothetical[d/]	Regression Estimate[e/]
	(1)	(2)	(3)	(4)	(5)
Largely increased output per hectare					
Colombia	27.4	1.2	515	349	241
El Salvador	81.5	3.1	516	559	569
Mexico	43.4	1.3	427	313	334
Morocco	18.1	3.1	291	291	206
Pakistan	25.2	11.3	397	343	325
Tunisia	9.0	1.6	328	316	-
Increased area and output per hectare					
Ivory Coast	9.3	1.3[b/]	148	148	138
Malaysia	40.6	2.0	357	375	324
Philippines	12.7	6.3	203	222	227
Thailand	10.7	6.0	305	152	191
Largely increased area					
Brazil	30.9	0.9	14	56	-
Ghana	4.1	0.6	-33	50	102
Iran	33.6	1.6	128	139	280
Paraguay	-0.1	2.4	-355	63	95
Sri Lanka	1.7	-1.7	56	93	66
Sudan	.3.9	4.6	-120	-120	-
Selected rapid-growth	24.6	3.0	215	-	-
Other DMEs	13.2	1.7	160	-	-
Selected slow-growth	5.8	1.5	29	-	-
All DMEs	16.4	2.0	177	-	-

Sources: Food and Agriculture Organization of the United Nations, (FAO) "Production Yearbook Tapes," for 1975 and 1976; and FAO *1976 Annual Fertilizer Review*.

a/ Based on the following data: Fertilizers, 1961/62-1965/66 and 1973/74-1975/76; arable land and irrigation, 1961 - 1965 average and 1975; output per hectare, trend estimates for 1964 and 1975.

b/ Based on area of temporary crops only.

c/ Based on the trend estimates for area and production.

d/ Hypothetical increases in output per hectare that would have occurred if cropping patterns had been unchanged but yields of each crop were those experienced.

e/ Changes in output estimated from the following regression based on 13 countries (omitting Tunisia, Brazil, Sudan) $\Delta Q = 7235 + 5.734\Delta N + 9.538\Delta I$; $R^2 = 0.82$; where Q = output per hectare of staple food, N = fertilizer per hectare, I = percentage of arable land under irrigation.

TABLE 4

Percentages of wheat and rice areas with high-yielding varieties, 1976/77; and cropping indexes, 1961-65 and 1975

Country	Wheat	Rice	Cropping Index[c/] 1961-65	1975
	(percent)			
Brazil	-	-	104	132
El Salvador	-	-	90	115
Colombia	-	69	-	-
Iran	3[a/]	-	-	-
Malaysia (West)	-	37[a/]	93	103
Mexico	89	79	-	-
Pakistan	75	40	112	116
Philippines	-	68	122	151
Sri Lanka	-	63[a/]	96	128
Sudan	50	-	-	-
Thailand	-	11	-	-
Tunisia	22[b/]	-	-	-

Source: Area percentages based on Dana G. Dalrymple, *Development and Spread of High-Yielding Varieties of Wheat and Rice in the Less Developed Nations*, Foreign Agricultural Economic Report No. 95 (Washington, D.C.: U.S. Department of Agriculture, September 1978).

Crop index from FAO "Production Yearbook Tape," 1975.

a/ 1975/76.
b/ Includes locally improved dwarf durum varieties.
c/ Ratio of cropped land to arable land (values above 100 indicated multiple crops on the same lands in one year).

in multiple cropping as measured by the ratio of cropland to arable land (see the cropping index included in Table 4.) This factor was of considerable importance in several of the Asian countries, where the introduction of early-maturing, high-yielding varieties, particularly in irrigated areas, greatly enhanced the opportunities for multiple cropping. Cropping intensities also increased in some of the Latin American countries.

The area of staple food crops expanded substantially faster than the total crop area in four of the rapid-growth countries, especially in Ghana and Sri Lanka. In Brazil, Iran, Paraguay, and the Sudan, a rapid expansion in the land used for all crops occurred. While the agricultural labor force has increased in 14 of the 16 countries, the

rate of growth in staple food crop area exceeded the growth of labor force in most of them. The wider use of multiple cropping and the increased emphasis on staple food crops appeared to be associated with the increased crop area per agricultural worker in several of the countries. Mechanization was a significant factor in area expansion in some countries. Changes in tractor numbers were used to provide some indication of the progress in mechanization (Table 5).

TABLE 5

Changes in tractor numbers in the rapid-growth countries, 1961-65 to 1975

Country by Category	Number of Tractors Per 1,000 Hectares of Total Crop Area		Average Annual Rate of Growth in Tractor Numbers, 1961-65 to 1975
	1961-65	1975	
			(percent)
Largely increased output per hectare			
Colombia	6.5	7.6	2.2
El Salvador	3.0	4.0	4.1
Mexico	5.2	9.5	5.7
Morocco	1.5	3.5	7.9
Pakistan	0.5	2.6	15.9
Tunisia	4.1	9.9	7.8
Increased area and output per hectare			
Ivory Coast	0.2	0.9	15.7
Malaysia	0.7	1.9	10.8
Philippines	0.6	0.6	2.3
Thailand	0.3	1.5	18.5
Largely increased area			
Brazil	3.0	5.5	8.8
Ghana	0.6	1.0	5.2
Iran	1.8	3.2	8.2
Paraguay	2.9	2.7	5.0
Sri Lanka	3.7	7.1	8.0
Sudan	0.6	1.4	13.0
Selected rapid-growth	2.3	4.3	7.7
Other DMEs	1.3	2.9	7.6
Selected slow-growth	0.8	1.6	7.0
All DMEs	1.6	3.3	7.7

Sources: Food and Agriculture Organization of the United Nations, "Production Yearbook Tapes," for 1975 and 1976.

Overview of Changes in Individual Countries

The wide variation in resource and technological changes among the 16 DME countries showing the largest sustained food production growth since 1961 suggests that a diversity of approaches is required

to achieve major increase in food production in developing countries. The experiences of the rapid-growth countries clearly indicate that no single factor or small group of factors can be specifically prescribed to attain rapid growth in food production. In several of the rapid-growth countries, large increases in staple food crop production appear to be associated with the shifts in demand for better quality foods. Growth in demand for livestock products, particularly in the middle- and high-income countries, greatly stimulated the production of staple food crops that are utilized for livestock feed, such as maize, sorghum, and in some countries, cassava. In others such as Ghana, the Ivory Coast, and Malaysia, the changes in the production patterns for staple food crops reflect more emphasis on cereals and less on root crops. Export demand appears to have stimulated the rapid growth of maize and cassava output in Thailand, and of groundnut production in the Sudan.

The wide range of the commodity sources of growth raises questions as to the need for intensifying local and international research and development efforts in developing countries to give emphasis to a wider variety of crops. While the well-known increases in rice and wheat production were important, more than half the increase in food output in the rapid-growth countries came from other crops less favored in research funding. The role of area expansion in increasing production in these countries has been much larger than is often suggested. Although policies emphasizing area expansion appear needed in some other developing countries, the study findings also suggest that such approaches must vary with the physical and economic conditions, and that problems of soil management may be increasing in some of the countries.

[Extracted from Chapters 1, 4 and 5 of Rapid Food Production Growth in Selected Developing Countries: A Comparative Analysis of Underlying Trends. Research Report No. 11 of the International Food Policy Research Institute (IFPRI), Washington, D.C., October 1979.]

Food Policy in China

C. Peter Timmer

[The methods used in China to assure supplies of basic foodstuffs for its very large population are of considerable interest. Mobilizing large amounts of manpower for building infrastructure, freeing farm labor for this by selective mechanization, pragmatic planning, and especially the reliance on economic incentives for small groups are among the important policies.]

That China has solved its food problem is the universal story brought back by medical, agricultural, and other scientific observers who have recently toured China. It is a claim made by the Chinese themselves. How could the world's oldest, largest, and in many respects most impoverished nation accomplish such a feat when the food prospects for many of the rest of the world's poor nations seem increasingly bleak? The U.S. National Academy of Sciences delegation that toured China in the summer of 1975 attempted to answer this question while observing small-scale rural industry and its interaction with agricultural growth. From the beginning it was clear that small-scale rural industry was not a goal in itself but was intended as a vehicle for imparting vitality into the countryside.

The solution to China's food problem involves two fundamental and connected components--increasing food supplies through agricultural growth, and ensuring access to those food supplies by means of socialist distribution mechanisms. Small-scale rural industry as one major component of China's food policy was observed directly; our observations, questions, and briefings provided information on the other. A substantial technical and scholarly literature exists on

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the details known to the outside world of China's agricultural development program. This article is not a review of that literature but rather is a broad sketch of the strategies used by the Chinese in their development effort, and of the mechanisms used to ensure that the entire population has access to the fruits of that effort. While it is convenient to treat these two topics separately, the Chinese emphasize that the social mechanisms of access and distribution are an integral component of the production system itself.

Increasing Food Supplies

Before the People's Republic consolidated its victory in 1949, China was among the most wretched of countries. The overwhelming misery and human suffering that existed are still vivid memories for the survivors, who tell and retell their stories to the younger generation which has not lived under the "triple yokes of feudalism, imperialism, and bureaucratic capitalism." The contrast between the peasant's life then and now is constantly invoked as motivation for and justification of the enormous physical effort and ostensible loss of personal freedom involved in the transformation of Chinese agriculture. The process of that transformation as it is described here does not depict the historical evolution of any single commune or region, but represents a purposeful abstraction of the development of Chinese agriculture. It is, in some sense, a model of Chinese agricultural development as the Chinese would like the visitor to understand it. Its purpose is to help us understand Chinese agricultural policy--to understand what the Chinese leadership wants to happen. Since the Chinese have adequately demonstrated a real capacity for implementing policies, this understanding is an important ingredient in evaluating China's success. How fast the basic model is diffusing across the Chinese countryside is a question answered only by time and the Chinese themselves.

Pre-Liberation Chinese agriculture was trapped in a low level equilibrium, with farm productivity balanced by the resources available and the incentives and organizational structures for change. Given the devastation of the economy during the Second World War and subsequent civil strife, some increase in food production would have been forthcoming under a private economy. But major progress was unlikely without substantial restructuring of land ownership and of the organizational mode of farming. These changes came sequentially with the land reform of the early 1950s, the primitive co-ops of the mid-1950s, and the final culmination of the Rural People's Communes in 1958. The organizational structures then existed that were capable of mobilizing vast quantities of surplus labor for large-scale projects, primarily involved in restructuring farmland and in carrying out major water control works; transportation facilities also absorbed much labor.

Some of the labor needed for such vast undertakings had been available in the slack seasons for many years. But much more was needed to attack and transform nature on the grand scale widely advertized by the Chinese and now attested to by a variety of uniformly impressed foreign visitors. This seemingly paradoxical need to generate more surplus labor provides the rationale for the first stage of agricultural mechanization--processing basic food gains by machines instead of by hand. Such mechanization became possible only when rural electricity began to be available, and the labor savings were truly enormous. According to a local Chinese spokesman, in 200 days of operation a commune-run rice mill of three tons per hour capacity saves about 2 million man-hours of labor. This saved labor is mostly female, but the argument is not weakened. Women work side by side with men in the water conservancy and farmland capital construction projects. A very substantial proportion of the total labor input in such projects involves moving soil and stone with baskets on shoulder poles. Women and men both engage in this task.

Two other important roles existed for the newly generated surplus labor. Cement is a critical ingredient in a wide variety of rural industrial and agricultural projects, and its production in small-scale rural plants is a unique feature of the Chinese model. These plants transform locally quarried limestone and coal into low- and medium-quality cement which is suitable for lining aquaducts and for mortaring bridges and terrace-retaining walls. The process from coal mine and quarry to production and use is enormously labor intensive and could not be conducted at its present magnitude without the workers freed by the first stages of agricultural mechanization.

The third role for surplus labor is to increase the amount of organic manure prepared and distributed to the fields. The new awareness of the finite supply of fossil fuels has prompted a number of recommendations in the West that energy-intensive agricultures should reduce chemical fertilizer applications in favor of organic manures. There seems to be little understanding, however, of the extent to which organic manure is merely congealed human labor. Organic manure has always been the mainstay of Chinese agriculture, but it was never applied in the past in the prodigious quantities now being used in the model areas because vast quantities of communally organized labor are required. Thus the generation of surplus labor within the commune permitted a substantial increase in the production and application of this vital yield-sustaining-and-raising input into Chinese food production. As an example of the enormous quantities of organic manure being used in some areas, our delegation visited communes applying over 200,000 kilograms of organic compost per hectare. Even conservative estimates of nutrient content indicate a nitrogen application of over 500 kilograms per hectare, which is high by any standard.

As the productivity potential of farmland was raised through leveling and terracing, and the risks from drought and floods were attenuated by irrigation and drainage works, opportunities emerged for extension of double cropping. Double-cropped rice land in the South has been common for centuries, but extension of the system northward and to other crops meant rapidly performing the harvest of the early crop and all the preparations for the second. These tasks are highly labor intensive with traditional techniques, and existing labor was already fully employed. The bottleneck was broken by the introduction of mechanical threshers, technically the easiest area of mechanization. Indeed, pedal operated, semi-mechanized threshers had been a fairly standard feature in double-cropped rice fields since the 1950s. But wheat threshing is technically more difficult because more power is required. Widespread mechanical wheat threshing awaited widespread rural electrification so that motor driven threshers on central threshing floors could be used.

Rural electrification has had an enormous impact on agricultural mechanization, and hence on generation of the labor surplus needed to "drive" the model, for two distinct reasons. First, the availability of electricity at the commune and brigade level has fostered an extensive network of agricultural machinery repair and manufacturing shops. All of the shops we visited had lathes, grinders, and milling machines. Many, especially at the commune level, are engaged in relatively large-scale manufacture of threshers, pumps, tractors, and similar items which would be impossible without electricity. Rural electrification, then, has permitted the diffusion of manufacturing and repair capability well into the countryside, with obvious advantages in terms of local access to agricultural machinery and its repair and the suitability of the machinery to local conditions.

Second, electric motors are the prime movers for a surprisingly large range of agricultural machinery. Most western agricultural machinery is designed to take the mechanical process to the field and to return with what is directly consumable. The Chinese view agriculture in a broader, more ecologically sound perspective. They bring more of the land's output to a central place--although ultimately more is returned to the land after composting and fermentation into organic manure. If the central place has electricity, a great many functions can be electrically powered that would otherwise be done by hand in the field before mechanization, or with gasoline or diesel engines afterward. Threshing tends to be one of the first field tasks mechanized, usually by an electrically powered thresher on a central threshing floor, often in conjunction with an electric fan to assist in winnowing. The low standards of construction and maintenance required for electric motors relative to petrol engines thus make many mechanization tasks cheaper and technically simpler, and hence more readily adopted in the countryside.

With increased potential for multiple cropping two other inputs become critical to further production gains: short-season, high-yielding, fertilizer-responsive grain varieties, and the chemical fertilizer to put on them. The evidence is now clear that the Chinese developed and widely distributed short-stature, high yielding rice and wheat varieties somewhat before similar advances were made by the international research institutes, especially the International Rice Research Institute (IRRI) and the International Center for the Improvement of Maize and Wheat (CIMMYT). The Chinese rice varieties did not have quite the yield potential of the early IRRI varieties but did have a significantly shorter growing season, which was essential to double cropping.

Although double cropping is not doubly exhausting to the soil relative to single cropping because yields usually do not double, substantially more nutrients are required on a long-term basis. These added nutrients are very difficult to provide strictly from organic manures, and so chemical fertilizers suddenly had a very high productivity if they could be gotten to the fields. In this context the small-scale rural fertilizer factories for which China is famous make excellent economic sense despite their apparent high costs in raw materials per nutrient ton. The factories use coal as the primary raw material to produce reduced hydrogen and then ammonia via the standard Haber process. The unusual aspect of the Chinese process is the end product derived from the gaseous ammonia. Instead of using technically sophisticated (and very expensive) compressors to convert the ammonia gas directly to anhydrous ammonia and possibly then to urea, as in modern plants, the Chinese rural factories compress the gas only enough to react it with other inexpensive agents to form ammonium nitrate (35 percent nitrogen) or ammonium bicarbonate (17.5 percent nitrogen). The first compound is a well known fertilizer and also an explosive when pure. The ammonium nitrate from Chinese factories is used for both purposes. The second compound is much lower in nutrient content and is little known outside China.

The capital costs of the rural fertilizer factories are substantial, even when much of the material and labor for construction is local and of low opportunity cost. The ammonium nitrate factory in Da Zhai, for example, required 33 tons of stainless steel, which is available only by allocation from the State. The banks of reciprocal compressors needed in either type of plant are made only in State factories. Thus the widespread appearance of these small-scale rural fertilizer factories was a clear signal of the timely understanding at the national policy level of the necessity to invest heavily in the food production sector if output was to be increased. But the operating costs of the small fertilizer factories are borne locally. These costs are mostly labor and raw materials, primarily

coal, which is actually labor just one stage removed if a local coal deposit exists. So once again, the necessity to create surplus labor is clear. Mechanization of threshing and processing seems to have been the most economical source of this surplus.

With these transformations the basic ingredients of high-yielding agriculture--water control, fertilizer, responsive seeds, and adequate labor for careful cultivation--were in place. The addition of high capacity pump sets to the hand-dug water control network permitted the high potential yields to become high and stable yields, which was the first priority of food production policy. The efficacy of the policy and the implementation was demonstrated from 1972 through 1974 when droughts struck much of northern China. It was a major achievement that Chinese food production did not drop significantly during this period.

Mechanization

Chairman Mao pointed out that "mechanization is the only way out for agriculture." Present plans call for the basic mechanization of Chinese agriculture by the early 1980s. In retrospect the mechanization of food processing, threshing, and some land preparation served as the catalyst to speed the labor-driven model for increasing and guaranteeing food supplies. For the future, widespread mechanization of land preparation, transplanting and harvesting will continue to free large volumes of labor, but except for some marginal increases in multiple cropping the yield gains will be small. In addition, mechanizing these tasks faces major technical difficulties.

Two important factors explain why land preparation is only beginning to show substantial progress in mechanization. The first is the level of technology required on a broad front to mechanize land preparation. The essential input is the tractor, either two-wheeled or four-wheeled. The tractor requires sophisticated engine making and repairing capacity as well as petroleum products available in the countryside. The second factor is that mechanizing land preparation leaves only a marginal role for draft animals in direct agricultural production. Since these animals play a substantial role in the generation of organic fertilizer, removing them from the farm scene in China is rather more complicated than it was in the United States where only their horsepower was replaced.

Mechanization of land preparation is further complicated by the pressing need for transportation vehicles in rural China. Large quantities of materials are still moved by shoulder poles, human-drawn carts, and animal-drawn vehicles of all descriptions. The temptation is enormous to substitute tractors for human transport labor. Since plowing with animals is easier work than transporting

materials long distances by hand, most tractors in the countryside seem to be on the road and not in the field. Many animals were seen by the delegation preparing the land for second crops; a much higher proportion of the winter and spring deep plowing may be done by machine. Nevertheless, it is not surprising that a production unit might decide to use its animals for plowing at low opportunity cost and use its tractors primarily on the road. This suggests that full mechanization of land preparation will only be attained simultaneously with the rural capacity to build small, locally adapted trucks. Only at this stage will it be possible to get rid of draft animals, thereby raising the opportunity cost of animal plowing.

Mechanical transplanting is still in its infancy, even in the model areas. Research and development in this area are being pushed vigorously as a further means of flattening seasonal labor demand peaks and speeding the turnaround time between growing crops in the field. Success in this effort will also make a major contribution to one other goal high on the list of priorities of Chinese leaders--to reduce the drudgery of agricultural labor. The Chinese do not shun hard physical work. Nearly everyone, including government bureaucrats and university professors, is expected to engage in some manual labor each year, preferably on farms. But the goal of policy is to reduce the gap between the physical effort involved in field work versus that in the factory. By narrowing this gap as well as the income differential between rural and urban areas, the Chinese feel they can dampen the presently strong preferences of rural workers to try to obtain factory jobs in cities. By reducing rural pressures to migrate to the cities, pressures thwarted at the moment by effective bureaucratic controls over access to urban food supplies (as well as other measures), the subsequent social overhead capital investment required to house and service adequately a large flow of rural migrants will be similarly reduced. The intent is to keep peasants on the farm by making rural work as attractive as possible.

The last stage of Chinese agriculture to be mechanized will probably be harvesting. The mechanical revolution in European and American agriculture began with harvesting; and similar large, uniform tracts of grain in the northeast of China are reported to be similarly mechanized. But mechanically harvesting small plots of intercropped grains is a different task. Small reapers mounted on walking tractors have been successfully demonstrated, but their use is not widespread. Small combines for wheat, which may be interplanted with corn (a popular new practice that raises the multiple-cropping index), may be feasible, but their development is in the design stage only. The Chinese custom is to remove all the straw from the field for fodder and composting; thus combines lose much of their potential advantage over simpler reapers. By either means great volumes of material must be carried out of the field, a task likely to be done by hand in the foreseeable future. Development of

suitable machines will no doubt be pushed, however. Like the transplanter, mechanical harvesters are justified for their contribution both to speeding the interchange of crops and to reducing the physical effort required of agricultural workers.

Speeding agricultural work by substituting machines for human labor raises the fairly immediate possibility of the kind of technological unemployment witnessed in a number of Asian rural areas. Eventually, and perhaps within a decade, a substantial proportion of China's rural population will not be needed in the fields. The Chinese are unconcerned about this eventuality. The reasons have to do partly with the distribution mechanisms discussed in the next section. If mechanization does not cause output to fall, then total agricultural income will remain the same and be communally shared. Such technological unemployment might better be termed leisure, which is as valued in China as elsewhere. But more important in Chinese plans is the continued potential to create productive new jobs for the labor saved in agriculture. Significant diversification away from crop raising and toward animal husbandry, fruit raising, beekeeping, food and fiber processing, and small-scale rural industries is already apparent even at the brigade level in some model areas. The share of these sideline occupations is expected to rise sharply as fewer workers are needed directly on the land. This transfer of workers from farm to factory is a feature of the development of all wealthy societies. The Chinese model is unique in that the transfer in this early stage involves shifts in occupation but not changes in location.

Incentives and Access to Food Supplies

Except for the unique aspect of employing the surplus agricultural labor in rural factories rather than in urban ones, the physical schema the Chinese are using to increase food production is entirely consistent with the classical surplus labor model of economic development outlined over two decades ago by W. Arthur Lewis. Implementation of the model is the critical issue. Any country could (and some did) place similar schemes on paper in ten- and twenty-year perspective plans. The Chinese are succeeding in transforming the plan into reality. If other poor countries are to learn any lessons for their own food policies from the Chinese experience, they must not stop with the physical model, although it is very important, but must also understand what the Chinese regard as twin complements to the physical model: the organizational and personal incentives needed to push the model from paper to field, and the social and bureaucratic mechanisms that distribute the resulting output.

Certain inevitable tensions exist between incentive and distributional policies in a society bent on guaranteeing minimal living

standards to all citizens while raising those standards on the average. China has not escaped those tensions, but it has attempted to balance them in a pragmatic fashion evolved from the results and lessons of many experiments. Many in the West view Chinese society, or at least the commune, as noble confirmation that individuals can join in an effort directed toward the general good without concern for individual reward beyond the shared public welfare. They think the guiding principle of Chinese distributional policy is the traditional Marxist formulation--"from each according to his ability, to each according to his need." The Chinese emphasize, however, that the reality is considerably more complex. The present formulation of the distributional rule in all but a very few circumstances is "from each according to his ability, to each according to his work." This rather Calvinistic expression demonstrates that at the heart of both Chinese distributional *and* incentive policies are individual material rewards for the human labor that drives the physical production model.

Wages in factories and offices are typically based on an eight grade scale where beginning wages tend to be half or less the level in the upper ranges. Cadre and technicians seem to be paid salaries well above the top level in the regular wage scale. The disparity in incomes generated by these differences is not large by private economy standards for either poor or rich countries, but it is not insignificant either. Recent attempts have been made to narrow the income gap by upgrading lower level wages without raising those in the upper ranges, or by promoting workers to higher grades so that a bunching in the upper levels exists. But these attempts do not seem to be widely popular, and strikes and work stoppages apparently have occurred in some areas. The current movement to study the theory of the dictatorship of the proletariat is designed to educate the workers on the desirability and need for uniform wages, but it also is a convenient way to postpone significant movement toward that goal while still recognizing its importance politically.

Distribution patterns in rural areas are more heterogeneous and complex than in urban areas. Work points, not wages, are the primary mechanism for compensating agricultural (and some rural industrial) labor. Each laborer finds the worth of a full day's work of different kinds collectively evaluated once a year. The criteria of evaluation vary from team to team and from commune to commune. All units give heavy weight to physical effort exerted and to skill levels; units also make adjustments for political consciousness. The number of work points earned each day is recorded in the books of the accounting unit, usually the production team (which tends to be a small village) although some "politically advanced" areas now use the production brigade (a cluster of perhaps ten to twelve villages) as the accounting unit. Communes are an important link between the villages and the central government (at the county level), but they do not seem to serve as the accounting unit.

At the end of a production year the gross value of output for the production unit is calculated. After subtracting costs for purchased inputs, taxes owed to the State, and deductions for various welfare funds within the administrative control of the commune (to pay for the the universal health insurance, investment or other accumulation funds, care for the aged, schools, and the like), the net value of output for the accounting unit remains to be allocated to individuals. The allocation is made simply by determining the total number of work points earned within the production team or brigade during the year and then the average value of each work point. Each individual then draws an amount equal to his or her total work points times the average value per work point. Typically, food withdrawals are made in advance of the final reckoning to carry households until the harvest, and deductions for these are made in the final reckoning at the State price for grain. In advanced agricultural areas households are free to buy as much grain as they need, within the limit set by their total accumulation of work points (and the likely value of those work points).

The level of accounting is the critical variable in distinguishing the Chinese system from traditional economic models. If the accounting unit were the individual, then the system would resemble a pure private agricultural wage economy. If the unit were the household, the system would resemble a traditional subsistence economy. As groups of households and entire villages are pulled into the accounting unit, the level of risk for an individual falls but so too does his perception of the link between his own effort and the resulting size of the harvest. Since work points do not depend on actual productivity but only on work effort, the larger accounting units tend to broaden the guarantee that everyone receives access to an adequate harvest. For example, two villages, one with extremely poor soil and one with rich soil, will have very different food consumption (or income) levels depending on whether they are two separate accounting units or whether both are included in a single accounting unit. In the separate case both sets of villagers can work equally hard, and yet one will prosper and the other will not. If both villages are in the same accounting unit, neither will face starvation, but the village with better resources will not prosper as much.

Not surprisingly, the type of income redistribution inherent in this second example has not proved popular with the more prosperous Chinese villagers. While there has been general willingness to incorporate families within a village or small area under the collective wing, this has been aided by familial ties and a strong traditional sense of community. These instincts have been reinforced by not pushing income redistribution very far. Accounting units tend to incorporate relatively homogeneous agricultural resources, so that it is easier to share the resulting output on the basis of work effort expended. Consequently the question of substantial differences in

incomes and living standards among brigades and communes has already emerged as a major challenge to Chinese leaders. Disparities of at least two to one can be observed between wealthier and poorer brigades within some communes, and of perhaps four or five to one between communes. These differences raise an inevitable pressure to broaden the accounting unit as a means of narrowing disparities in income, but so far the pressure has had little impact. The Chinese leadership has repeatedly emphasized that the major reason for differentiating productivity and income levels is the willingness of the people to put "politics in command."

National agricultural policy is encapsulated in the motto, "In agriculture, learn from Da Zhai." Despite the most barren land and limited water resources imaginable, the Da Zhai production brigade succeeded in achieving high and stable yields for food grains, diversifying their agriculture through mechanization, and rebuilding their miserable village into a town that regularly receives international visitors among the thousands of Chinese who daily make a virtual pilgrimage to view the miracle. The lesson of Da Zhai is startling and simple: Do not complain about lack of resources. Do not ask assistance from the State. Mobilize the workers and set them to transforming the fields, to finding water, to digging coal, and to making cement. Higher living standards are available to any production unit that has the political will to mobilize. And the rewards will accrue to those who earn them.

A strong material incentive exists to increase production. The incentive in the first instance is to the accounting unit collectively. But since the rural Chinese seem to have found a satisfactory balance between the individual and society at the level of the production team, the incentive to individuals are perceptible. Strong political leadership at the team level can make the vision of the collective production gains quite real for the individual. The tension between distributional equity and private incentives is used creatively to set the task of local political cadre. If the cadre are good, prosperity grows. If they are not, backwardness continues until either the peasants force the issue or higher levels select new leaders.

Prices

Implicit in the network of physical changes occurring in commune agriculture is an entire set of financial incentives and flows that reflect the accounting needed to make the system function. Wages and work points measure only the accounting prices for the labor flows. Similar accounting must be done for the machinery, fertilizer, electricity, and other commodities and inputs. The accounting is usally in physical units and labor work points for flows entirely within the accounting unit; but accounting for flows from one unit to another and,

more importantly, from one level to another is nearly always done with prices. The levels at which these prices are set and the extent to which they change are an extremely important part of the overall climate of inducement to increase food production.

The price of food grain relative to the prices of critical inputs needed to produce food grain, and especially the fertilizer price, is a critical variable in determining the climate of production incentives. In the decision making of market-oriented farmers in Asia, the evidence is strong that this grain/fertilizer price ratio plays a major role. The evidence suggests that the variable is important in China also, but that important differences exist. Increasing fertilizer applications is a major source of higher food grain yields once the agronomic potential has been generated by means of water control, improved cultivation practices, and the availability of high-yielding varieties. Within a given price context fertilizer use can be increased, often dramatically, by policies that reduce the risks of using fertilizer and that develop farmers' understanding of the yield increments to be expected from fertilizer applications. But in China, as elsewhere in Asia, the price context itself is used as a significant part of the overall package of inducements to raise yields.

Prices for both grain and fertilizer are set by the State, and no trading of either commodity is permitted in free markets. The control of food grain prices especially seems to have been effective for over a decade. At the same time that urban prices have remained stable, the farm prices have been raised somewhat on several occasions (requiring some State subsidy to pay the marketing costs). As rural fertilizer factories sprang up and imported fertilizers became more widely available, the rural prices of chemical nutrients have been reduced. The very conscious effect has been to raise the grain/fertilizer price ratio as an inducement to production teams to intensify fertilizer applications as part of their effort to achieve higher yields. The intentional policy of using price incentives in this effort is seen even more clearly in the premium prices paid by the State for sales of grain above a commune's basic quota. This premium seems to range from 20 to 50 percent above the basic quota price.

Average rice yields in China are somewhat higher, given the price for within-quota rice, than would be suggested by the experience of six other tropical rice-growing countries. The price-yield relationship is even more impressive for the high and stable yield areas of China which are able to produce enough surplus grain to earn the premium, above-quota price. Indeed, these areas are as productive as the rice areas of Taiwan. They demonstrate how remarkably successful China has been relative to other Asian experience in integrating a package of yield-increasing technology into an atmos-

phere made financially attractive by very low risks and high awareness of input productivity. The high and stable rice-yielding areas of China are consistently impressive for the uniformity of the fields, a uniformity not to be seen elsewhere in Asia. It is attributable to meticulous cultivation organized collectively and spurred by a set of incentives that reward success.

Access to Food

Providing access to locally self-produced food is not a major problem once the production effort has succeeded. But two other difficult problems remain. First, in the rural areas, what is to be done about villages, families and individuals that are unable to share in a successful production effort? Second, how are food supplies to be guaranteed in urban areas?

The problem of excluded individuals and families is not widespread in China because of the strength of the extended family bonds. Three-generation households are still the typical case and are encouraged by the government. The occasional individuals who do not fit into a family and who cannot work are cared for in special homes run with local welfare funds. Families with too few able-bodied workers to earn sufficient work points to provide adequate food are supplied from local reserves accumulated as part of the welfare fund. Decisions on the size of this fund and the distributions from it are made by all members of the production unit; the procedure resembles collective charitable action much more than a bureaucratic welfare scheme. Since the recipients are always well known by the collective decision-making group (indeed they are usually part of it), few opportunities for abuses exist.

Areas that have not managed to achieve high and stable yields for their basic food grains are much more vulnerable to natural calamity. Drought or floods would cause general starvation within localized areas if grain supplies from outside the afflicted area were not provided quickly and cheaply. The central and provincial governments have been very successful in building reserves from domestic surpluses and from imports to provide such grain, and no significant famines have been reported in China since the founding of the People's Republic. (During the bad harvests from 1959 to 1961 famines were avoided by careful distribution to the neediest areas; stores of grain were not available.) This impressive achievement has been possible, of course, only because of the rapid improvement of substantial portions of Chinese agriculture. Those rural areas that have received emergency grain supplies have also been pushed hard toward local self-sufficiency. The model of Da Zhai is a constant embarrassment to any locality that must receive grain from the State. No local political leadership can expect to

survive for long if it must resort regularly to State grain supplies. It is true that communes well suited to producing high yields of important industrial crops, especially cotton and silk, are permitted to buy grain regularly from the State; but even these communes are not permitted to eliminate grain production entirely.

The net result in the rural areas has been firm guarantees that no one will starve, but also equally firm pressures for that guarantee to be made good from local resources. The only way for a region to join in the promise of better living standards is to make the political commitment to local food self-sufficiency. Once such an effort is clearly underway, the State has mechanisms to provide assistance--access to special steels and compressors needed to build small-scale fertilizer factories, access to certain critical machine tools to begin a local agricultural machinery industry, and access to engines and sometimes tractors from State factories. But such access comes only after the local commitment; the rural communes, brigades, and teams must take the initiative.

Providing the food supplies to the cities is an entirely different task. There can be no quid pro quo of food production effort in return for guarantees of emergency food supplies when deficits hit. Cities are by their very nature centers of continuing food deficit. This perpetual need, and the social investment required to keep a person in a city, are the major reasons the Chinese have stopped the growth of cities. They have even sent many people back to their villages, where they can produce some of their own food themselves and also diminish the food deficit in the city.

The State has four primary sources of grain supplies for urban areas. The agricultural tax provides about one third of all grain deliveries to the State. The amount is relatively fixed because the rate is set per hectare and does not change when yields change. There is little opportunity for significant extension of cultivated acreage in China, and land reclaimed and improved by terracing, water conservancy, and other investments is temporarily exempted from taxation. The leadership is loath to raise the land tax rate because of the adverse effect on incentives to raise yields. Little flexibility exists with this grain source, and there is small prospect for growth.

Commune grain sales to the State, according to quotas set by historical productivity levels, provide the rest of urban grain supplies procured internally by the State. The price of sales within the quota has gradually increased since 1949, but, relative to fertilizer prices at least, it is low by other Asian standards. In 1970, for instance, when world rice prices were at their lowest in many years, the relative price paid for within-quota rice in China

was about the same as the floor price paid in Indonesia; only Burma and Thailand paid their farmers less. In Indonesia, however, this price was substantially higher than farmers had received historically, and farmers began to respond enthusiastically. In China, where such prices had been guaranteed for much longer, the production response was more nearly complete. Grain quotas seem to be raised periodically, but not as a regular response to higher yields. The attempt to keep the two separate is made for incentive reasons because sales to the State above the quota receive a substantial price premium.

Imports provide a fourth and important source of urban grain. Wheat imports in both 1973 and 1974 exceeded five million tons, most of which were allocated for urban consumption. Such imports, after the claim in 1971 that China was self-sufficient in food, need to be viewed in their proper context. During the same years China exported about two million tons of rice at significantly higher prices than it paid for wheat, a neat calorie arbitrage. Secondly, transportation facilities to bring rural grain to urban cities are limited and heavily overworked. Since Chairman Mao's call to "store grain everywhere" the decision has been made to build significant rural reserves of grain rather than burden the transportation network by moving the surplus to the cities. Imports then have served to build urban reserves for possible hard times ahead, and at the same time to free railroads and trucks for higher priority shipments.

Rationing

With adequate urban grain supplies assured, the mechanism of distribution remains to be discussed. The system of universal grain rationing for urban dwellers is without doubt one of the major factors which makes the Chinese system unique and successful. Cooking oil and cotton cloth are also rationed. Families receive food grain ration coupons in quantities determined by the age and composition of the family and by the occupation of the wage earners. The rations are presently large enough so that many families do not consume their entire allotment. To discourage waste and the sale of surplus coupons, "savings accounts" for grain have been set up where families may turn in their surplus food coupons each month and accumulate reserves that can be drawn on for special feasts at weddings, holidays, and so on. The grain is not physically stored in a warehouse, but as long as confidence exists that the grain will be available when needed, small reserves are sufficient. The system itself seems to have engendered the feeling among urban families that food is plentiful. Their ration supplies, bought at low and guaranteed prices, are more than adequate. No household hoarding is needed. It is far better to let the State store the grain and to avoid the trouble and expense. Since hoarding greatly exacerbates what may

be only marginal scarcity, this scheme has an enormous social payoff. Occasional slight shortages do not get turned into food panics.

The system of rationing the minimum necessities of life so they can be sold at very low prices also solves the problem of access to food supplies for the poorest of the population. Apprentice and low grade worker wages are very low in China, and even with cheap housing, medical care, and transportation, such workers would be unable to compete on a price basis for food. The rationing system guarantees that everyone has access to basic food and clothing. The poorest people will have little access to anything else because meat is expensive, and so are the light industrial products widely available throughout China. But, as the Chinese are quick to point out, China is still a very poor country. The wonder is not that many families cannot afford bicycles, transistor radios, or daily servings of meat, but that all can have three adequate, if starchy, meals each day. The magnitude of this accomplishment in today's hungry world must not be lost in either polemics or adulation. Hard work, sensible and sensitive policies, and an amazing pragmatism and flexibility in the face of failures are the ingredients of China's success.

[Extracted from Food Research Institute Studies, Vol. XV No. 1, 1976, pp. 53-67.

Food Security: An Insurance Approach

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[Efforts to obtain security in food supplies of the developing countries by price stabilization and a buffer stock face various difficulties. An insurance approach, with or without an international grain reserve, could provide an alternative offering additional benefits. A particular type of scheme to insure countries against the hazard of major increases in import costs if food consumption levels are to be maintained is described; its probable costs under different operating rules are estimated, and do not seem unreasonable.]

Much of the debate in recent years over how to attain food security has concentrated on the desirability of accumulating large buffer stocks with the objective of stabilizing the world price of grains. A number of developed countries, both importers and exporters, advocate such an approach for reasons having to do with the operation of their domestic food and agricultural policies. For developing countries, price stability resulting from buffer stocks would mean moderation of the often wide fluctuations in foreign exchange expenditures required to purchase food imports. But even with grain price stabilization, a country will still have a food insecurity problem to the extent that its domestic production fluctuates.

Apart from the degree of food security provided, several problems are inherent in such an approach. It is not clear that nations will be able to agree on the size, location, price bands and administration of the buffer stocks that would form the backbone of a price stabilization scheme. There are important differences among major participants about what production adjustment and trade policy measures should be used if buffer

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stocks are not adequate to keep prices within the specified range. If a group of countries reached agreement on buffer stocks without inclusive participation, member countries would want to exclude non-member countries from the benefits of stable prices. To do this, members in the scheme would have to design some system of export controls or discriminatory pricing to bar non-members from reaping benefits, and such action would invite political or trade retaliation that could ultimately break the system. And even if a group of nations could agree in principle on a price stabilizing arrangement, agreement on a cost-sharing formula would be difficult to work out. It is not possible to estimate accurately the actual monetary costs and benefits for all the participating nations. Moreover, a price stabilizing arrangement does not allow individual countries to select the degree of food security they desire, and thus does not allow them to reduce their share in the cost. In some countries food production is highly variable, in others relatively stable; some nations have enough foreign exchange to absorb variations in domestic production by buying grain in the international market while others do not. Therefore, the degree of food security desired will vary.

Finally, pursuit of short-run self-interest by grain exporters and importers thwarts the negotiation and implementation of a price stabilization arrangement. During years of good harvests, when low grain prices and ample supplies encourage the initiation of a buffer stock system, importing nations see no urgent need for one. But, when poor harvests have forced grain prices up, exporting countries show little interest in buffer stocks that would set an upper limit on the international grain price. This obstacle to grain stocks clearly would disappear if policy makers took longer-term considerations into account. However, the usually short planning horizon of governments and the political pressures of interest groups in both exporting and importing nations bias decisions toward immediate gains. As a result, proposals for grain buffer stocks face serious obstacles caused by the divergence of short-run interests.

Description of the Insurance Approach

By limiting the scope of an agreement and specifically addressing the needs of food-deficit developing countries, the international community could avoid some of the problems associated with a full-scale market-price stabilization agreement. One way would be to design an agreement along insurance principles.

The two sources of food insecurity in developing countries are: (1) a temporary reduction in domestic food production, and (2) a temporary increase in international foodgrain prices. If a proposal deals only with the first source of food insecurity, it implicitly assumes that food-deficit developing countries can overcome the second source

by varying their foreign exchange expenditure on food imports. But such variable spending of scarce foreign exchange could severely hamper overall economic development in many developing countries. Therefore, to protect developing countries from both sources of food insecurity, a food security scheme must deal with fluctuations in their food import expenditures.

This study follows that approach in principle, with certain refinements. First, rather than treating developing countries as a group, this study estimates the level and variability of grain production and the import requirements of each country individually, taking production and consumption growth into account. Second, it clearly specifies operating rules at the country level, allowing an objective estimate of benefits received by each country. Finally, this study estimates the cost of an insurance scheme for a period of five consecutive years rather than for a single isolated year. The specified objectives of the food security scheme analyzed here are: (1) to permit developing countries to stabilize food consumption within a range of projected food demand, and (2) to permit developing countries to stabilize their food import bill within a range of their trend import bill while stabilizing food consumption. "Adjusted target consumption," which is the consumption level to be defended by the system, will remain between 95 and 100 percent of the cereal demand projected for each country. A country's actual consumption levels might be higher or lower than adjusted target consumption; but adjusted target consumption is the basis for determining year-to-year transactions between a country and the system.

In years of very high world prices and/or very low domestic production, a country could become eligible to draw from the system's resources in order to maintain its adjusted target consumption level. Withdrawals from the system depend on the variability of each country's cereal import bill, and on the degree of insurance desired. (Throughout this paper, the term cereal is used to refer to wheat, rice and feed-grains; wheat is taken as the basic staple commodity, and the value of cereal imports is computed as if these imports were composed entirely of wheat.) The system would make payments only for the amount by which a country's actual import bill exceeds a certain percentage of its trend cereal import bill. Should a country desire a high level of insurance, it could set this uninsured import bill level very low, and thus draw frequently from the system. This discussion assumes an uninsured level of 110 percent for all countries (two alternative levels of 120 and 130 percent are evaluated later). The amount of compensation due to a country is calculated by first computing the country's target food imports in a given year (i.e., adjusted target consumption minus current production), and then valuing these imports at the current world price. If the value of target imports exceeds 110 percent of its trend import bill (i.e., the cost of its imports as projected from past trend), then the country is eligible for compensation from the system for the excess bill over 110 percent of the trend value.

A system which requires a country to make some adjustment in consumption before providing compensation payments creates an incentive to maintain production at least at its trend level. But if the system provided coverage for a full 100 percent of each country's projected demand, then there would be no means of preventing a country from drawing excessive short-term benefits by deliberately underreporting domestic production, or reducing its resources allocated to food production.

An international food insurance scheme that would provide member countries the resources to defend their consumption can operate in either of two ways: (1) the scheme can serve as a purely financial mechanism that provides member countries with funds to cover overruns in their cereal import bill; or (2) the insurance scheme can operate a limited size grain reserve in addition to the financial mechanism; grain would be released to eligible member countries when world food supplies are very short. Both of these alternatives will be examined.

A food insurance scheme operating as a purely financial compensatory mechanism implies that the system provides member countries with the funds necessary to cover overruns in their cereal import bill. Recipient countries use these funds to import food to meet their consumption targets.

Table 1 presents several possible transactions between a hypothetical country and the system. In year 1, actual production in the country in question (row 7) is 90 percent of trend (rows 2 and 9). The rules of the system set adjusted target consumption at 95 percent of projected demand, or 10.45 million metric tons (row 9). The difference between adjusted target consumption and actual production (row 10) multiplied by the current world price (row 1) yields the size of the target import bill (row 11). Because the target import bill for year 1 ($137.8 million) is less than 110 percent of the trend import bill ($165 million) (row 6), the country receives no compensation from the system (row 12). In year 2, actual production is 98.06 percent of trend and adjusted target consumption is set at 11.18 million metric tons (i.e., 98.06 percent of projected demand). With the target import bill smaller than 110 percent of trend, the country again receives no compensation in year 2. In the third year, actual production exceeds trend, so adjusted target consumption equals projected demand. The combination of a good domestic crop and a low world price during this year results in a target import bill considerably lower than the trend import bill. The country is again ineligible for compensation from the system. In year 4, however, low domestic production and high world price result in a much higher import bill. The target import bill equals $395.0 million, considerably more than 110 percent of trend import bill (which is equal to $214.5 million). Thus, the

Table 1— How a food insurance scheme operates as a compensatory financing mechanism for a hypothetical country during a five-year period

	Year 1	Year 2	Year 3	Year 4	Year 5
1. Current world price of wheat ($/MT) a/	95.0	140.0	110.0	250.0	180.0
2. Cereal production trend (million MT)	10.0	10.3	10.7	11.2	11.7
3. Projected cereal demand (million MT)	11.0	11.4	11.9	12.5	13.1
4. Trend cereal imports (million MT) b/	1.0	1.1	1.2	1.3	1.4
5. Trend cereal import bill (million $) c/	150.0	165.0	180.0	195.0	210.0
6. 110 percent of trend import bill (million $)	165.0	181.5	198.0	214.5	231.0
7. Actual cereal production (million MT)	9.0	10.1	11.0	10.3	11.8
8. Actual production as percentage of trend production (%) d/	90.0	98.0	102.8	92.0	100.9
9. Adjusted target consumption (million MT) e/	10.45	11.18	11.90	11.88	13.1
10. Target cereal imports (million MT) f/	1.45	1.08	0.9	1.58	1.3
11. Bill for target imports (million $) g/	137.8	151.2	99.0	395.0	234.0
12. Compensation to country (million $) h/	0.0	0.0	0.0	180.5	3.0

a/ For this illustration only, assume that the average world price of wheat equals $150/metric ton.

b/ Computed as the difference between row 3 and row 2.

c/ Computed as the product of row 4 and the assumed average world price of wheat ($150/metric ton).

d/ Computed as the ratio between row 7 and row 2.

e/ Computed by adjusting projected demand (row 3) on the basis of the values of row 8 as explained in the text.

f/ Computed as the difference between row 9 and row 7.

g/ Computed as the product of row 10 and row 1.

h/ Computed as the difference between row 11 and row 6 when the former is larger than the latter.

country is eligible for compensation in the amount of $180.5 million ($395.0 million minus $214.5 million). Finally, in year 5, although the country has a better than average crop of its own, a continued high world price results in an import bill that still exceeds 110 percent of trend import bill. Thus, the country receives compensation in the amount of $3 million.

A food insurance scheme as a combined grain reserve and compensatory financing mechanism. A system that used a grain reserve in conjunction with a compensatory financing mechanism might provide a more cost-effective way of achieving the same objectives. Moreover, the presence of a grain reserve adds an important supply guarantee to the system. In high-price years commercial stocks are ordinarily very low or nearly depleted, so that merely providing financing in these years cannot guarantee availability of supplies. In fact, compensatory payments may bring higher prices and greater financial strain on food importing countries, as more buyers bid for scarce supplies on the world market. Exporting countries may also prefer a system with a grain reserve, since the reserve would protect them against consumption adjustments or the need to impose export controls during high-price years. Appropriately managed, a relatively small reserve could help to guarantee supplies and conceivably reduce the cost of the system, while minimizing its disruptive effects on the international grain market.

A food security system with a limited reserve would have to specify price levels at which it would acquire and release grain. The correct choice of these price levels is crucial to the system's success. On the one hand, a low acquisition price and a high release price mean less interference with the world grain market. On the other hand, there should be at least a reasonable probability that the world price will trigger acquisition and release sometime during the period for which an international insurance scheme is negotiated if it is to serve its purpose.

If, for example, a food insurance scheme has an initial projected life of five years, a release price reached in only one year out of thirty would be unrealistic, since there would be a very low probability that the system would use its grain reserve. Conversely, a release price that is reached in two years out of four would interfere unnecessarily with the free market. With these considerations in mind, a release price which will be exceeded in one year out of five, and an acquisition price which will be exceeded in four years out of five, have been assumed. Given the world price distribution for wheat (i.e., its variations over a previous period), an acquisition price of $105 per metric ton (with about 80 percent probability of being exceeded) and a release price of $200 per metric ton (with about 20 percent probability of being exceeded) can be specified. Using these

prices, the system could expect to acquire grain in one year out of five on average, and to release it in one year out of five.

Once the world price reaches the release price, production levels in member countries will determine which ones are eligible for compensation in the form of grain. When high prices trigger the grain release mechanism, countries whose production falls short of trend by more than five percent are eligible to bring their grain supplies up to 95 percent of trend by drawing upon the system's reserves, to the extent that such reserves are available.

Thus, consider again the hypothetical country illustrated in Table 1. During the year 4, the high-price year, domestic production in the country in question is 92 percent of trend production, so the country is eligible to draw from the grain reserve facility of the system. The 95 percent level of trend production equals 10.64 million metric tons, so the country receives 0.34 million metric tons (10.64 minus 10.30) of grain. Use of the reserves reduces the compensatory financing received by the country in question for that year by the value of the grain released to it--i.e., by $85 million (0.34 x $250). The country receives the remaining $95.5 million (180.5 minus 85) in compensatory funds. If the grain available in the grain reserve facility of the system is not enough to cover all requests, then each country's allotment is reduced in proportion to the available reserve.

Cost of the Scheme Under Alternative Rules of Operation

The costs of operating a scheme of the general type described for 65 Third World countries were estimated, based on data for 1960-75. [For particulars on methods of estimation, see original study.]

Alternative insurance levels. The criterion for a country's eligibility for compensation from the scheme in a particular year is the comparison of its current cereal import bill with its trend import bill. The initial analysis assumed an uninsured import bill of 110 percent for all countries; that is, when a country's current import bill exceeds 110 percent of its trend import bill the country is eligible for the amount of this excess. To examine the sensitivity of cost to the level of insurance provided by the scheme, alternative levels of 120 and 130 percent for all countries have been evaluated. Under these alternatives each country is eligible for compensation from the scheme when its cereal import bill exceeds 120 percent or 130 percent of its trend bill. (Although it would be possible under this scheme for countries to select the insurance level desired, this analysis does not compute the cost of a scheme which assigns different insurance levels to different countries.)

Table 2 presents the overall cost of the scheme under these three alternative insurance levels. The total cost values in this and the next table are expressed as present values of the estimated stream of expected costs, discounted at an 8 percent rate. The figures show that a higher uninsured level reduces the cost of the scheme substantially. Operating the scheme as a compensatory financing mechanism at a 120 percent uninsured level results in a cost reduction of $760 million compared to operating the scheme at a 110 percent level. A 130 percent level further reduces the cost by $658 million.

TABLE 2

Expected present value of the cost of the scheme operating under alternative insurance levels

Cost Components [b]	Scheme Operating as a Compensatory Financing Mechanism Only — Uninsured Import Bill Level			Scheme Operating as a Combination of a Compensatory Financing Mechanism with 20 MT of Grain Reserve [a] — Uninsured Import Bill Level		
	110 percent	120 percent	130 percent	110 percent	120 percent	130 percent
	(million dollars)					
Cost of compensatory financing	5,108	4,348	3,690	4,006	3,247	2,603
Cost of grain reserve						
Acquisition cost [c]	...	...	...	1,800	1,800	1,800
Carrying cost [d]	...	...	...	775	775	777
Salvage value [e]	...	...	...	1,426	1,426	1,436
Total	...	...	...	1,149	1,149	1,141
Total cost of the scheme	5,108	4,348	3,690	5,155	4,396	3,744

a/ The compensations are in the form of funds when the world wheat price is below $200/metric ton. When the world wheat price exceeds $200/metric ton, part of the compensations are in the form of grain valued at the world price. The grain is released to countries that experience greater than 5 percent production shortfalls and in amounts (to the extent available) to bring the physical availability of grain in every country to 95 percent of production trend.

b/ In computing present values a discount rate of 8 percent has been assumed.

c/ An acquisition price of $90/metric ton has been assumed.

d/ The carrying cost was calculated on the basis of a variable rental cost for storage facilities of $10/metric ton per year.

e/ The salvage value of the residual grain in the system at the end of the five-year period was based on the prevailing market price for that year.

The costs for the same three insured levels for a scheme operating with a 20 million metric ton grain reserve in addition to the compensatory financing mechanism are practically the same as those just mentioned. It should be noted that almost all of the reduction in the total cost of the scheme comes from reductions in its compensatory financing component; the grain released from the system is the same under all three alternatives. This implies that regardless of the level of insurance provided, countries will not receive grain from

the scheme as part of their compensation until their cereal import bills substantially exceed 130 percent of their trend import bills.

Alternative rules for grain release. In the preceding analysis two factors trigger the release of grain from the grain reserve facility: (1) the world price of wheat; and (2) individual country production shortfalls. The system releases grain only in years when price rises above $200 per metric ton and then only to countries that experience a shortfall of more than 5 percent during those years. These release rules favor grain release when it is most needed; they might be considered conservative, since there is only 20 percent probability that the world wheat price will rise above $200 per metric ton. Moreover, the probability is very low that some countries will concurrently experience shortfalls greater than 5 percent and high grain prices. Thus, it is interesting to explore alternative release rules for the system. Two alternative grain release rules have been analyzed. In the first, the release price is reduced to $170 per metric ton. (There is a 32 percent probability of exceeding this price.) In the second, the release price is kept at $200 per metric ton, but grain is released to countries with a shortfall greater than 3 per cent. Such countries will receive grain, to the extent available in the system, in amounts that bring the physical availability of grain to 97 percent of trend production.

Table 3 shows the results of this analysis. Changing the release rules has very little impact on the expected total cost of the scheme. There is, however, a significant reduction in the compensatory financing component of the cost, particularly with a reduced grain release price of $170 per metric ton, which reduces this cost by almost half a billion dollars. This occurs because more grain is released at a lower release price. Even though the net cost of the grain reserve facility is now higher due to the substantial reduction in the salvage value of the left-over grain at the end of the five-year period, there is still some saving in the total expected cost of the scheme (about $150 million). Moreover, changing the release price trigger from $200 to $170 per metric ton results in a higher probability that grain will be available in later years than changing the production shortfall trigger from 5 to 3 percent. Thus, if a choice between these alternative grain release rules should need to be made, reduction in the release price would be preferable.

Conclusions

The different cost figures derived in the previous section must be put into proper perspective. One important distinction needs to be made: insurance plans for automobiles, property, or health involve a very large number of participants, and the risk factor is continuous

TABLE 3

Expected present value of the cost of the scheme operating as a compensatory financing mechanism in conjunction with a 20 million metric ton grain reserve under alternative grain release rules

Cost Components a/	Release Rules: Price Greater Than $200/Metric Ton Shortfall Greater Than 5 Percent	Price Greater Than $170/Metric Ton Shortfall Greater Than 5 Percent	Price Greater Than $200/Metric Ton Shortfall Greater Than 3 Percent
	(million dollars)		
Cost of compensatory financing	4,006	3,548	3,874
Cost of grain reserve			
Acquisition cost	1,800	1,800	1,800
Carrying cost	775	713	769
Salvage value	1,426	1,068	1,323
Total cost of grain reserve	1,149	1,445	1,237
Total cost of the scheme	5,155	4,994	5,111

a/ A discount rate of 8 percent has been assumed. The excess over 110 percent of trend in each country's current cereal import bill is covered.

over time. Thus, the probability that the actual cost will be close to expected cost within a given period is extremely high. An international food insurance scheme, on the other hand, involves both a limited number of participants and a non-continuous risk factor. As a result, the actual cost of operating the scheme for a limited period might differ significantly from its expected cost.

Whatever the form of its financial resources (cash in hand, scheduled premium payments, borrowing capacity, or standby pledges), a food insurance scheme of the type described in this paper will not be established unless it can function at a cost that seems reasonable to its funders. If a high degree of certainty is desired that funds will be available to meet the objectives of a food security scheme, the amount of those funds will have to be very large, even though there is little likelihood that the scheme will actually cost that much. If a lower degree of certainty is acceptable, the potential cost of the insurance scheme will be considerably lower, and the reduced initial capital requirements are more likely to seem reasonable to probable funders of the scheme. In the event that the scheme's funds do not fully cover requirements in some years, target consumption will have to be adjusted proportionately for all participating countries. Since funders will certainly set an upper limit to the financial capacity of any food insurance scheme, the question then becomes, what is the best use of a given level of funds?

To indicate the range of options which funders might want to consider, Table 4 presents the probabilities associated with different cost levels above the expected cost for six scenarios: three insurance levels without reserves, and three insurance levels with a grain reserve of 20 million tons. The associated probabilities indicate the degree of certainty one may have that the funds available will be sufficient to cover all claims against the system, either in the form of money or grain. These clearly show that achieving a high probability that the objectives of the scheme will be met substantially raises the cost of food insurance. For example, under scenario II (scheme operating solely as a compensatory financing mechanism with an uninsured import bill of 120 percent of trend) an additional financial capacity of $0.8 billion increases the probability level from 70 to 75 percent, whereas increasing this probability from 90 to 95 percent requires $3.8 billion.

TABLE 4

Funds required to attain a given probability that the scheme will achieve its objectives under alternative methods of operation [a/]

Alternative Scenarios on the Operation of the Scheme	Expected Cost	Probability of the Scheme Achieving its Objectives (percent)					
		70	75	80	85	90	95
		(billion dollars)					
Scheme operating as a compensatory financing mechanism only, with uninsured import bill of							
I. 110% of trend	5.11	5.1	6.1	7.3	9.4	12.1	16.7
II. 120% of trend	4.35	4.1	4.9	6.0	7.9	10.7	14.5
III. 130% of trend	3.59	3.3	3.9	4.8	6.4	8.7	12.5
Scheme operating as a compensatory financing mechanism in conjunction with 20 MT of grain reserve, with uninsured import bill of [b/]							
IV. 110% of trend	5.15	5.1	5.6	6.1	7.0	9.5	13.2
V. 120% of trend	4.40	4.1	4.4	4.8	5.7	7.7	11.2
VI. 130% of trend	3.74	3.3	3.6	3.9	4.7	6.1	8.9

a/ The scheme attains its objectives when it has adequate funds to compensate member countries under its rules of operation.

b/ The cost figures under scenarios IV,V and VI include also the net cost of the grain reserve (about $1.1 billion). Grain is released in years when world price exceeds $200 per metric ton, to countries that experience greater than 5 percent production shortfalls in those years and in amounts that will bring the physical availability of supplies (to the extent available in the system) to 95 percent of trend production in all countries.

There is, however, a trade-off between the level of insurance provided and the probability that the objectives of the scheme will

be met. For a given financial capacity, a high level of insurance implies a high risk of depleting funds during the last years of the five-year period, thus favoring countries that happen to draw from the scheme early in the period. Therefore, lower insurance coverage (uninsured import bill of 130 percent of trend) with a high probability (90 to 95 percent) of defending the scheme's stated objectives should be preferable to high insurance coverage (uninsured import bill of 110 percent of trend) with a lower probability (70 to 75 percent) of achieving the objectives.

Another consideration is the presence or absence of a grain reserve in the system. Although a grain reserve has virtually no effect on the probability that the scheme will meet its objectives if funding is provided at the expected cost level, additional funding above the expected cost makes a scheme with a grain reserve preferable since it provides a higher probability of achieving its objectives. This effect is greater the larger the size of the reserve. In addition, as shown earlier, a larger reserve provides a higher probability of maintaining supply availability in eligible countries at 95 percent of trend production during high-price years. For these reasons, if a grain reserve were established in conjunction with a compensatory financing mechanism, a grain level of 20 million metric tons for developing countries is suggested.

If it is reasonable to assume that most countries can manage import bill overruns up to 130 percent of the trend import bill without assistance, then the expected present value of the cost of the scheme amounts to about $3.7 billion, of which about $1.1 billion is the cost of a 20 million metric ton grain reserve. This level of funding implies a probability of at least 75 percent that the scheme will successfully defend its objectives. A probability level of 90 percent might require up to $2.4 billion more during the next five-year period.

Source of funds. A crucial component in the success of this scheme is the source of funds needed for its operation. Three alternative approaches to financing the scheme are discussed: (1) self-financing by participating countries; (2) financing primarily by developed countries, with some contributions from developing countries; and (3) financing through a compensatory financing facility of the International Monetary Fund (IMF).

Under the first alternative, member countries would pay annual premiums in proportion to their expected benefits during the five-year period. Countries could pay equal premiums every year or, depending on their year-to-year overall foreign exchange position,

they could pay variable annual premiums, larger when foreign exchange position is good, smaller when it is poor. Based on expected total withdrawals, annual premiums by country can be computed. For example, if India had to pay an equal annual premium for the next five years, that premium would range from about $206 million to about $245 million, depending on the level of insurance provided by the scheme. The funding provided by this approach would cover only the expected cost of the scheme, so there would be about 25 percent probability that the scheme's funds would run out. If funds ran out, then the scheme would either have to borrow the cost overruns up to the limit that had been set, or it would have to adjust compensation to eligible countries so that all shared the burden proportionally.

The longer the life of the scheme, the closer the cumulative disbursements at any point of time will be to the cumulative premiums paid in; over a sufficiently long time the scheme itself would be able to repay past debts or to meet by itself any higher than expected current costs. However, if the scheme's life is abruptly terminated after the initial five-year period, the scheme will very likely be left with either a surplus or a deficit in its overall receipts versus disbursements. If the scheme has a balance other than zero on termination, then surpluses should be refunded to and deficits paid by member countries according to their net contributions to the scheme.

In practice, most of the low income countries could not participate in a self-financed scheme without help from developed countries. A food security scheme designed to maintain consumption in developing countries when world prices are high would permit these countries to rely on commercial imports for an increasing percentage of their growing food requirements. Therefore it would be to the advantage of grain exporters in particular to contribute to such a scheme.

Under the second funding alternative, developed countries could provide assistance in a variety of ways. If they chose to do so, they could finance the scheme along with the richer of the developing countries without reference to the distribution of benefits among recipient countries. In this case, donor countries could simply make a collective commitment to finance the scheme at an agreed level. Contributions could be made either in the form of money or in the form of grain set up as a reserve on behalf of the scheme. The cost of setting up the grain reserve could perhaps be the responsibility of the major grain exporters.

Another possibility would be for the donor countries to make commitments to pay a specific percentage of the premiums required

from low income countries. A collective effort by developed countries to subsidize the scheme in this way would be desirable from the point of view of recipient countries because it would stipulate a regular flow of financial assistance on terms known in advance. But donor countries might not, for various economic and political reasons, want to commit themselves rigidly to this approach. Many of them might prefer to integrate existing food aid commitments into the scheme, rather than or in addition to providing direct financial subsidies to eligible participants. At present, food aid flows are not always responsive to the particular requirements of recipient countries for which they are intended. Incorporating variable food aid commitments into a food security scheme could remedy this situation.

For countries willing to contribute to the financing of a food insurance scheme through their food aid programs, there are several options. Food aid can be used instead of funds to subsidize the annual premium payments of low income countries. In certain years, the donor nation might make a food aid contribution to a beneficiary country in lieu of a dollar payment to the food insurance scheme. Assume, for example, that an insured country is obligated to pay an annual premium of $10 million to the food security scheme in order to guarantee a certain degree of domestic food security, and that a donor country has pledged a contribution of $5 million (half of the annual premium) on behalf of this country. Suppose that during a normal year the country needs to import $20 million worth of food to meet its consumption targets. Thus, during a normal year this country will have to spend a total of $25 million for food imports plus its participation in the food security scheme. If during a particular year an excessive grain supply in the donor country makes it more desirable for the donor to make its pledged contribution in the form of grain, it can do so by contributing $5 million worth of grain directly to the beneficiary country. The beneficiary country will then have to import only $15 million, and this $5 million savings on its normal import bill plus the $5 million that it has allocated for its participation in the insurance scheme will cover its required premium for that year.

Food aid could also contribute directly to the stabilization of domestic food supply in the recipient country, so that the country will seek a lower degree of protection from the food insurance scheme and thus reduce its annual premium payments. Because domestic supply fluctuations in the recipient country will not in general coincide with the capacity of the donor country to provide food aid, such aid could be used when available to build up a reserve in the recipient country. If stocks created from food aid contributions provided protection against a certain level of domestic production shortfall, then this country should seek coverage from the food insurance scheme

in excess of the insurance it provided itself. The premiums needed in this case could be considerably lower than those for full coverage.

A third alternative for funding a food security scheme is through a compensatory financing facility within the IMF. This could be done be creating a new facility specifically to cover overruns in cereal import bills. Or the cereal import bill could be taken into account along with fluctuations in commodity export earnings in determining whether a country is eligible for compensatory financing from the existing facility. Funding through the IMF's compensatory financing facility is a reasonable and just solution because it takes into consideration the foreign exchange position of a country in a given year. More important, the mechanisms that could put such a scheme into operation have already been established and tested, thus precluding the need to establish a new bureaucracy.

In addition to funding arrangements, several other issues will require attention. The foremost problem to be resolved is the identification of reliable data sources to be used in determining which countries are eligible for compensation, and the exact amounts they are eligible for each year. For the initial five-year period, production trends and consumption projections could be estimated with a high degree of accuracy--with some refinement the figures developed in this analysis could be used. The remaining data problem will then be the accuracy of future annual production figures. An international authority would have to determine whether a reported production shortfall is the result of genuine adverse weather conditions, or whether it results from a country cutting back resources in cereal production or deliberately under-reporting its production performance.

Another issue deals with the administration of grain, if grain stocks are held in the system. The problem of trigger prices for starting grain acquisition by the system has been noted. The location of a reserve is another issue that usually emerges in discussions of internationally held grain reserves. Ideally, the grain reserve should be located as close as possible to countries that are more likely to call upon it, assuming that high quality storage facilities exist. Alternatively, on the assumption that grain exporting countries would share in the cost of the scheme either by collectively providing part of the grain reserve or by integrating into the scheme their current food aid programs, grain exporters could hold part of the grain reserve on behalf of the scheme in existing storage facilities. Major grain exporters might be willing to waive carrying costs by including them in the cost of achieving their domestic agricultural policy objectives. The location of grain reserves is a politically sensitive issue for reasons of self-reliance; from a practical point of view it appears that negotiations should focus on a few

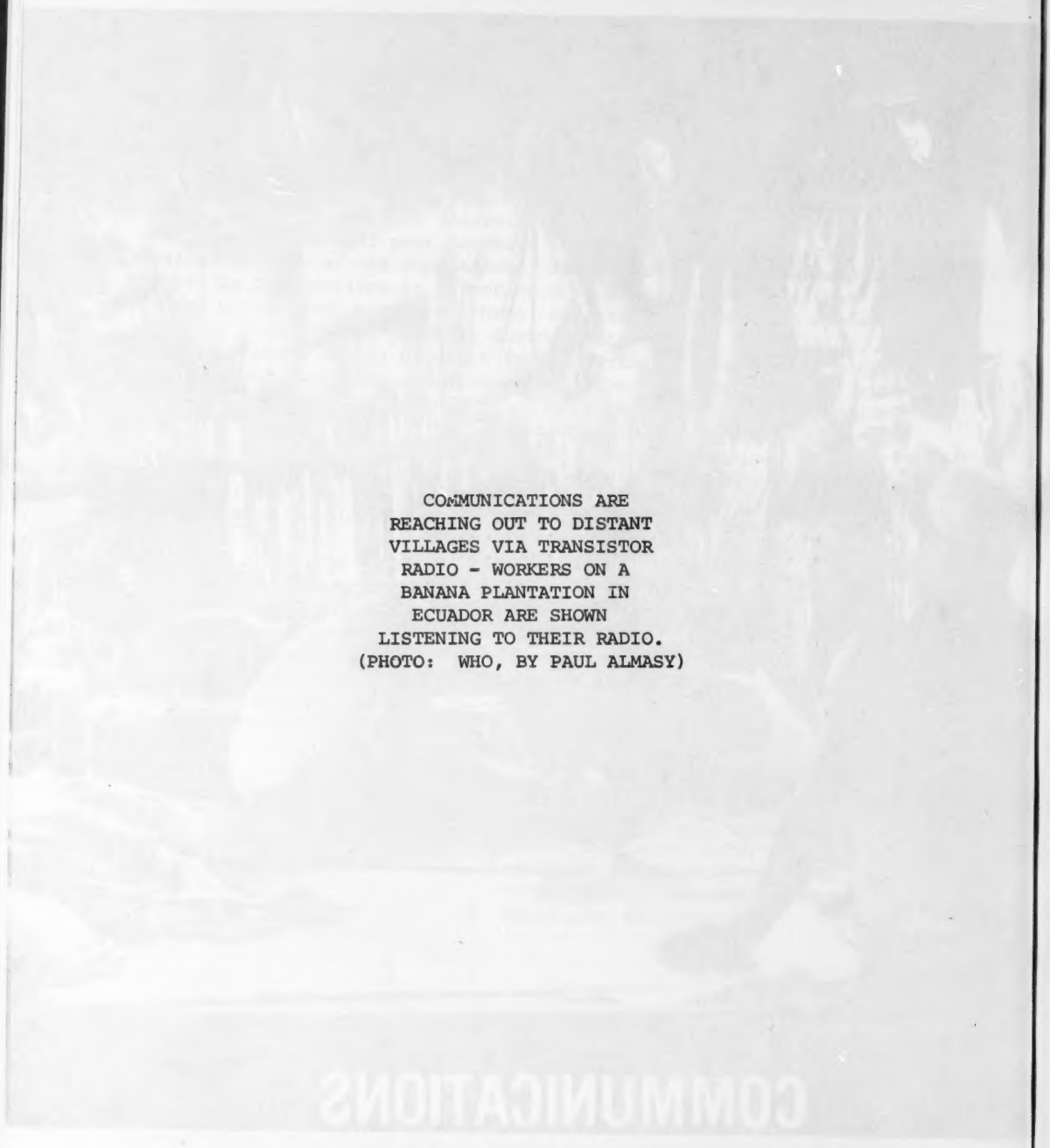
storage sites close to large contributors and to large expected users of the grain.

Finally, food-deficit developing countries will have to develop internal policy instruments to insure that the steady flow of grain imports obtained by a country's participation in the food insurance scheme reaches the poorest part of its population. In most developing countries agriculture generates a large portion of the income of the poor, so years of poor harvests imply lower buying capacity for a large portion of the population. If the reduction in consumption caused by this decline in effective demand is greater than that tolerated by the food security scheme, countries will need to operate internal food subsidy programs during these years. In addition, since the added supply of grain from an external source will keep prices lower than they would have been otherwise, farm incomes will be rather low from a combination of poor harvests and prices depressed by added supplies. Thus, domestic policy would have to provide income compensation to grain producers to negate possible adverse effects on their earnings.

In summary, this paper has presented a food insurance scheme to deal with the food insecurity problem of food-deficit developing countries, a scheme whose cost proves to be within the reach of the international community. The world food problem is no temporary phenomenon, and the earlier a comprehensive effort, such as the one suggested here, is made, the better. The environment for initiating this effort may never be more favorable in terms of currently available grain supplies. Should this effort prove fruitful, more countries will undoubtedly seek to join, and the chances of alleviating mankind's ultimate problem will be greatly enhanced.

[Extracted from Food Security: An Insurance Approach, Research Report No. 4, September 1978, of the International Food Policy Research Institute (IFPRI), Washington, D.C.

COMMUNICATIONS



COMMUNICATIONS ARE
REACHING OUT TO DISTANT
VILLAGES VIA TRANSISTOR
RADIO - WORKERS ON A
BANANA PLANTATION IN
ECUADOR ARE SHOWN
LISTENING TO THEIR RADIO.
(PHOTO: WHO, BY PAUL ALMASY)

The Governance of Broadcasting: Government, the Audience, and Social Groups

Ithiel de Sola Pool

[Broadcasting by radio and television is governed in a variety of ways, depending on national conditions. This article discusses the effectiveness of broadcasting in promoting national development, and some techniques and policies that can increase credibility and acceptance of content.]

How a nation's broadcasting system should be organized depends on what one wants that society to be. Electronic communications are the nervous system of a modern society. They are bound to both reflect and shape people's lives, relations with each other and with their government. Thus, in order to consider alternative ways in which a broadcasting system might be financed, governed and internally organized one ought to start by considering how broadcasting relates to the various social groups that make up a society, what they believe, what other modes of communications are available to them, and what are their development goals.

These are big questions. They are questions of social and political philosophy. Technical questions that social research can answer may be embedded in them, but the full answers involve judgments of value and also the exercise of wisdom in the presence of uncertainty. In short there is no 'state of the art' about how to organize a broadcast system. In the last analysis, the issues involve fundamental political theory. What kind of a state does one want? What kinds of autonomous initiatives contribute to or obstruct national policy?

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A nation is too complex an organism to be moved by a single decision center. The relationship of the parts to the whole in a polity has been the subject of a large literature by such authors as Rousseau, De Tocqueville and Weber. The most important recent contributions to this field have come out of organization theory, which has once more reaffirmed the awareness that the power of any organized unit (be it a firm or nation) is a function of the multiplied initiatives of its many members and therefore depends on their motivations. Innumerable studies by organization theorists have shown lateral and informal communication and multiple initiatives to be the condition of effective achievement of goals defined for the entity by its unifying leadership. These studies have also shown that the key role of the leadership of an organization is most often not its exhortation of the many subordinate leaders who must act, but the presentation of a role model to them. Although these findings have many implications for broadcasting, they lead to no simple solution for broadcasting policy. They are guidelines that should be kept in mind, whatever organizational structure one chooses.

The Place of Broadcasting in the Total Communication System

In developed societies an integrated communication system serves a multiplicity of purposes. It serves government, business, education, public health and private life. All of these have legitimate communication needs. All of them require an easy flow of messages among all points in the land and among all its citizens. They all share in the use of telephones, printing presses, and broadcasting. One problem confronting developing countries is how to overcome fragmentation by building a comprehensive communication system in which all can talk to all and which serves a variety of social needs.

There is the danger that a communications system designed by one set of institutions and with one set of purposes in mind will fail to meet other needs, i.e., that it will be 'sub-optimized' by being used for one narrow set of purposes. A number of historical examples can be given. In the US, where it started, the telephone system was designed as a business service to provide calls for paying subscribers. Communal needs were not adequately considered. Consequently, fire and police alarms had to be set up on separate and less adequate networks. Phone circuits were not available, as they could have been, as an all-point alarm system instantaneously accessible to anyone from anywhere. Similarly, broadcasting in some countries has developed as an entertainment medium to serve advertisers, and in other places as a propaganda medium for the government. In the former case there is the danger that no provision will be made for allocating some portion of spectrum time for serious broadcast purposes. In the latter, there is the danger that the commodity distribution system of the country will be denied access to the most effective means of informing consumers about the products that business is trying to make

available. In both situations, education is likely to get inadequate allocations of broadcast facilities. Somehow, communications facility planning--whether through a market or through consultative processes--should be based on inputs from all institutions as to their prospective needs.

Communication system decisions made today will affect what will be available fifty years hence, and will influence how every element of society functions and performs. Broadcasting is a growing component of a modern communications system. Even in the most advanced countries, where broadcasting has been a live activity for over fifty years, studies show that every year a larger portion of the people's news consumption comes from broadcasting as compared to print media. Educational use of broadcasting is growing almost everywhere. In developing countries where literacy is not universal and where a powerful independent press has yet to take root, broadcasting is even more important. Since the transistor revolution radio has been their main news source.

But even if broadcasting is a country's main source of information and entertainment, it cannot function in isolation from other media. Broadcasting provides a means for support and dissemination of the work of film-makers, traditional artists and journalists, and it depends upon the prior existence of such cadres and their skills. Without them, broadcasting stations would have little to broadcast. Furthermore, broadcasting is only one of the many kinds of communication that a society needs. Being few in number, broadcast channels must necessarily address mass audiences. A vital role remains for print media, film, field agents, poster, telephone, mails and traditional arts that transmit specialized messages to groups both large and small and to individuals. Broadcast planning should take into account its relationship to all these other media.

Comprehensive communication planning requires that broadcasters and the post/telephone/telegraph (PTT) coordinate their long-range planning activities. By working together they can reduce duplication of facilities, and avoid investment in incompatible equipment that may later present obstacles to interconnection. Currently, the principal areas which require close broadcast-telecommunication cooperation are microwave and satellite systems for nationwide message distribution. In the near future, particularly in rapidly developing countries, there will be other areas of overlapping facilities between broadcasting and point-to-point transmission. As spectrum limitations force broadcasting, especially for such purposes as education, to make more use of such media as cable or optical fibers, both broadcasting and point-to-point transmission can share the same networks. Conversely, to reach isolated villages with message traffic, the airwaves and broadcasting receivers may be the most economical

means, using off-hours or sidebands or regions of the spectrum which are otherwise unexploited. In short, planning for broadcasting is an integral component of planning for a total communication system and should be carried out with the country's total communication needs in mind.

Not very many countries have done a satisfactory job of comprehensive communication planning. *A priori* one might assume that such planning would be best done in countries with centralized planning and nationalized communications monopolies, but this is not the case. In such societies broadcasting falls under the jurisdiction of politicians who are not much interested in engineering questions, while telecommunications falls under the jurisdiction of engineers. With two powerful national monopolies at the helm one tends to find warring baronies rather than coordination. Thus, in the Soviet Union, the most extreme example of a centrally planned society with nationalized service monopolies, broadcasting is a Party matter under the All Union Committee for Broadcasting, whereas telecommunications are handled within the normal ministerial structure. The relations between them are remote. In Canada, on the other hand, and to a lesser extent in the United States, a loose, decentralized system provides for greater interplay between the two electronic communications sectors. In Canada, broadcasting is handled at the Provincial level, and 40 percent of all homes receive their television signals by cable. Phone companies have assisted in cable-laying, but most cable systems are independent. In parts of Canada the phone company is publicly owned; elsewhere it is private. This variety of patterns has allowed for constructive experimentation with all possible relationships between broadcasting and telecommunications. These experiments are monitored by the Canadian Radio and Television Commission which, like the American Federal Communication Commission, regulates both broadcasting and telephone.

The most typical pattern, worldwide, comes closer to the Soviet than to the Canadian extreme. A government department runs telecommunications. A separate government department or public corporation has a monopoly on broadcasting. There is little interaction between them at the policy level except for the fact that the broadcast network may be a customer of the PTT.

The Relationship of Broadcasting to Society

In any highly pluralistic society it is essential, both for the different groups themselves and for national integration, that broadcasting present over the air the activities and interests of the various social groups. Radio and TV are mirrors of the society. It is important for the self-esteem of citizens who belong to different social groups that they see themselves in that mirror. It is impor-

tant for mutual respect and, therefore, for social peace that others in the society see prideful images in that mirror of social groups whom they might otherwise disdain.

The presentation of pluralistic images is more likely to contribute to national unity than to fission. The appearance on the air of figures with whom individual citizens can easily identify contributes to the acceptance of the messages conveyed. In many developing countries fear of regional divisions has prompted governments to centralize all broadcasting in the capital, and to present on the air a single style of person with a single accent. The result has been to deprive provincial authorities of a major tool for implementing regional programs and to give broadcasting an alien, elitist image.

The face and voice of the person on the television screen does not command instant authority by virtue of his role. Unlike the father of a family, the policeman on the block or the mayor of a city, he has no other relations with the audience that draw their respect. His appearance, his style, his way of talking, must somehow draw him out of the crowd. He cannot be characterless. He must be a striking human being with distinctive features that become his hallmark. Features that groups can identify with are particularly important if he is to act as their spokesman. And he must also stand out as a man of exceptional character. In short, a popular broadcasting system with mass appeal requires "stars".

This may seem ironical. Simplistic popular political theorizing sometimes presents a polarity between democracy, in which all are equal and which is therefore leaderless, and aristocracy in which there are elite individuals. However, since ancient times sophisticated political theorists have understood that in some respect the opposite is true. It is oligarchies that most strenuously combat 'the cult of the individual'. Competing oligarchs do not wish anyone among them to develop a mass following. Conversely, democracies, as Plato, Aristotle, Ibn Khaldun, Moise Ostrogorski and Max Weber pointed out, require 'demagogues' (in the Greek sense) or charismatic leaders to mobilize a popular following. Thus, if broadcasting is to serve as an initiator and mobilizer of public action it must do it through distinctive stars with whom people can identify.

A nation is too large an organization to function with all initiative taken at the center. There are limitations of time and attention, as well as limitations of imagination and empathy, both by those at the center and those out at the grass roots. Emotional attachments are strongest to persons with whom one has some human contact, as every politician knows. Television does not change these facts. It should work with them. To be seen on TV is a useful halfway step to being seen in person. However, the face seen on TV whom

no one knows or has ever met in person, who has no shared relatives with one's own relatives, who has no known private life like one's own, is simply not às credible as the TV spokesman who is also part of one's own circle. Consensus about the purposes and programs of the center is more likely to be achieved by representatives of diverse elements talking to each group, rather than by appeals from the center itself.

For effective broadcasting by different social groups, it is not enough to present pictures of different regions, costumes and tribes. There is a limit to the extent to which even the most talented producer can create programs which are meaningful to people who differ greatly from himself unless he draws them directly into the production process. Members of the relevant social groups can usefully be involved in the planning and creation of programs. Mechanisms for such participation include advisory committees, local origination, and feedback programming in which local activities are used for program material and members of the group are invited to express their reactions. Such programming can contribute to credibility, and it offers the opportunity of presenting the unity in diversity of the nation.

Credibility. Without credibility among its audience, a broadcasting system is at best a bulletin board for notices and a conduit for entertainment trivia. If a broadcast system is to activate a people it must be trusted.

Credibility is a serious concern, for credibility is a fragile matter. It is easily compromised and hard to regain. Credibility requires that the broadcaster can be counted on by his audience to tell the truth in regard to the things he discusses, and also to address himself to matters which the listener considers important. Evasion as well as distortion compromises credibility. Credibility can also be served by putting spokesmen on the air whom listeners already trust. Credibility is aided by the broadcaster having a status that is recognized as independent from government pressures: discussing issues impartially, presenting alternative views on controversial issues, airing problems that really trouble people, and providing a channel between people and government.

Three additional points need stressing. First, if television is perceived as just a part of some remote elite status or of the government, the suspicion may arise that the medium does not give relevant information or the whole truth. To counter this, the role of television as a professional, free and independent journalistic medium must be assured by its charter. Second, viewers must not think of television programs as shows produced by an insular metropolitan clique. On the contrary, viewers should consider themselves as active participants. This can be achieved in part by a program policy which en-

courages as much as possible participation by ordinary men and women. For such fieldwork program production, special training should be provided for the program staff. Third, the image which the communicator projects on the screen makes a difference. The broadcast organization should analyze what kind of communicator is desirable in the current political and socio-cultural context.

In many field experiments an attempt has been made to create programming that is credible in rural areas. Senegal, for example, has a weekly program in which an issue is discussed by villagers and tape recorded. The announcer then invites letters from other villages about the same problem, which are then read over the air and answered by a high government official. [See Development Digest October 1974, p. 103.] Experience has shown that when development plans are discussed at the village level and broadcast over the air the interest is greatly enhanced.

The Role of Broadcasting in Social and Economic Development

Social and economic development is development of people. To achieve it requires learning, motivation and effective communications. A broadcasting system provides the government with means to promote and explain development plans and their implementation, to provide a link between the government and the people.

Too often those who engage in developmental planning think only of providing the economic prerequisites of development such as capital, or, if they think of motivation at all, of economic incentives. While these are important considerations, attention should also be given to psychological planning for mobilization. Broadcasting organizations should be attuned to fulfilling that role. It is one of the main contributions they can make to development. Broadcasting organizations can explain to government departments and other authorities the potential of electronic mass communications in support of development, as well as their limitations. They can advise government and other development agencies on the psychological dimensions of programs, and can advocate before planning and other development agencies the requisite communication aspects and resources for persuasion.

Developmental broadcasting demands close coordination with the concerned government departments and other institutions responsible for implementation. It would be pointless, for instance, to promote a new seed variety if it is unavailable in the localities where it is to be publicized on the radio. Broadcasting for developmental purposes requires very special skills that not all broadcaster have. Development broadcasts should have entertainment value as well as other qualities. Broadcasting organizations in rapidly developing countries must provide training which goes beyond classical broad-

casting training and includes an understanding of all aspects of the development process and the use of communications media for it.

As a development agency, a broadcasting organization has the critical responsibility of activating the human potential of the country and its cultural development. This contribution to development can be provided not only by serious educational programs but also by those whose primary aim is entertainment. Entertainment programming can present audiences with role models for new ways of life, and can fulfill an informative role as well as, or even better than, programming which is more purposively informative.

Implications. So far we have laid out some basic considerations for the governance of broadcasting in a rapidly developing country. These include the structure of a total national communication system of which broadcasting is but a part; the social structure of the country; the need to establish credibility with a diverse audience; and the priority of the goals of rapid development. We now turn to some conclusions that seem to follow.

1. *Value of non-broadcast activities to the broadcaster.* Broadcasting cannot be developed in isolation. Along with broadcasting stations, a successful system depends upon the existence of electricity, distributors, and repair shops around the country. Broadcasting requires performers, writers, journalists and directors. The development of national cultural institutions must move forward on many fronts simultaneously. If there is to be appreciation of the country's ancient art, textbooks must teach about it in schools, museums must exhibit it, universities must train historians and archeologists to document it. TV producers must have a source of material available to them. The development of culture is more than development of radio and TV.

Because of their mass appeal radio and TV are apt to move ahead faster than other cultural institutions. They do not require literacy, and reach everywhere at low incremental cost. For its own well-being the broadcasting industry ought to help develop other cultural institutions which would otherwise lag behind. Since such related activities are not central to the organization, a broadcaster might perhaps spin them off when and if they acquire the ability to become self-sustaining. This would be a wise exercise in self-restraint and a way of avoiding the atrophy that often accompanies excessive growth. The unique capability of a broadcasting network to start the ball rolling should be recognized. It knows its audiences. It has the experience. If a broadcasting organization is to fulfill its role as promoter of economic and social development, it must inevitably branch out into auxiliary activities. To teach courses over the air it must distribute associated printed matter. To engage in agricultural ad-

vice programs it must maintain liaison with field agents. Its activities must be defined by its substantive goals rather than by a particular means of transmission.

2. *Research provides policy guidance.* Broadcasters need a two-way relationship with their audiences. Credibility as well as effectiveness in promoting development depends upon an understanding of an interaction with the many social groups that make up the audience. Research is an instrument for getting to know the audience better. It is a voice of the audience. It helps the broadcaster avoid the danger of transmitting only the limited views of his own social milieu.

Research takes many forms and requires a variety of skills.

-- Library research contributes to the content of programs.
-- Audience research provides data on audience composition, size, type and interests, and helps broadcasters to be responsive to their audiences.
-- Effects research reveals audience attitudes, values and behavior.
-- Needs analysis at both the national and audience level specifies program requirements.
-- Organizational and systems research on the broadcast institution itself serves to identify the best combination of resources and their management for responding to changing requirements and opportunities.
-- Program testing and the evaluation of pilot material contribute to the development of innovative concepts.

In view of the importance of research and its potential but fragile capability for objectivity, we should consider how research activities ought to be linked to programming and operating policy. Research organizations need budgetary and other flexibility to allow them some freedom of initiative. Autonomy serves both to sustain the creativity of researchers and to stimulate research ideas, the best of which are likely to come out of the researcher's own experience and expertise. At the same time, if the research is to prove of practical use the researchers must maintain close liaison with policy makers. A number of conclusions follow:

(a) Research units ought to report to the highest policy levels. While programming departments may have some internal research requirements, research in general will not be objective nor will its results be properly applied if it is not lifted above the pressures of day-to-day production.

(b) There should be rapid dissemination of research results to all levels of the organizations where they may be used.

(c) Researchers within the broadcasting organization should maintain contact with professional colleagues in other institutions, and should act as translators of research results into terms the policy makers can understand.

(d) Research provides background information and *post facto* evaluation. In addition, by operating in a daily, repetitive manner in the production cycle it should answer questions raised by producers as they arise.

(e) Research may at times provide useful program material by identifying people's interests and concerns.

Relationship of Broadcasting to the Government

Throughout the world one finds a variety of arrangements for the governance of broadcasting, ranging from pure government monopoly to purely commercial systems. Other arrangements include broadcasting by public corporations, by universities, by churches, by voluntary associations, and by combinations of the above. There may be a single broadcasting organization or several competing ones.

The relationship between management of programming and of transmission also varies. In France and Holland, for example, one monopoly operates the transmitters for several broadcasting organizations. In Holland a number of producing organizations share studios, wavebands and transmitters. In the United States, on the other hand, each broadcasting organization owns its own physical facilities (i.e. "hardware").

The only aspect in the hardware-software relationship that is universal is that, in broadcasting, software (i.e., program contents) considerations are dominant. Whereas in telecommunications systems engineers are generally in charge, in broadcasting organizations political, marketing, and cultural specialists have the upper hand. The top men may be drawn from the fiscal or marketing areas, from programming, or from politics. There may be one production organization or several. The production organization may be an integral part of, or distinct from, the broadcasting stations which create the daily schedule, and also from the transmission organization. Broadcasting stations may be loosely federated into a cooperative network, or run by a national organization. There may be one network or several competing ones. Where there are competing networks there may be a mixed system, as in Britain and the United States, where some networks are private and some are public.

At the structural level there is no single answer to what is the most desirable system for all countries and for all times. The structural form of broadcasting organizations is determined by particular socio-economic, cultural and political factors operating in any given society, the resources available, and the number of channels. Rela-

tionships between media and government change as new social, economic and technological environments emerge. In all circumstances, however, broadcasting has relations with government. Government needs channels through which to talk to the people; the people, for their part, need information about their government. Furthermore, it is the government which by law determines the basic policies and structures under which the national communication system operates. Government allocates the broadcasting frequencies. In most countries government provides all or most of the funding for broadcasting. And governments may, by their controls, undercut the effectiveness of broadcasters.

There is need for strong protection of the autonomy of broadcast organizations, whether they are broadcast monopolies or competing networks. This need follows directly from the importance of credibility; to win its listeners' confidence a broadcasting organization must show that it is devoted uncompromisingly to doing its job, and is not the agent of outside forces.

Autonomy means independence of broadcasters in their professional role, not autonomy of a social elite. This latter form of autonomy develops easily because broadcasters are inevitably drawn from the better educated, professional strata of the population. The autonomy that is desired is that of broadcasting professionals acting responsibly. To achieve it while resisting the temptation to become 'a happy few' requires continuous interaction of the independent professionals with their audience by the various means mentioned above: research, feedback and participant programming, and decentralization of the system. Autonomy is fostered by professionalism, protected financing, strong traditions of broadcast independence, and an appropriate structure of the broadcasting organization. Organizational mechanisms that protect broadcasting autonomy include tenure for broadcasting staffs, high position in the state structure for the director general, and governance by a board independent of both the government and the broadcast organization. Such a board of directors can act as an intermediary between the government and the director general in the case of disputes. Its membership may be drawn from universities, journalists' associations, arts and business, or may have members appointed or elected by interested parties such as recognized national associations and the government.

With autonomy goes responsibility. Broadcasting organizations must provide access to the air for diverse elements of the population. This can be done by making available specialized channels, or specialized programs within general channels, through advertisements, public service announcements, interview programs--and most important of all by local and decentralized programming.

Discussions of relationships between power centers such as government and the broadcasting organization often degenerate into assertions

of formal authority. It is easier to engage in legalistic definition of roles than to describe how two large organizations interact. The relationships between large social institutions are polymorphous and occur at hundreds of different organizational levels. The symbiotic relations at these levels often determine whether and how policies will be implemented. If intervention and control between government and broadcasting organization were to occur only at the summit level, the real power of one institution over the other would be small because effective exercise of power requires many points of linkage. What is likely to happen if the top authorities are the only point of linkage is a deadlock (not unlike negotiations between superpowers) with each head official unable to yield any point that might open up unforeseen troubles in the large structure below him. Only when middle and lower level personnel interact with one another in the carrying out of program can effective action be taken. In other words, joint programs require that authority be delegated to inter-agency links.

Financing. A successful broadcasting organization must have an adequate and sufficiently stable source of funds to retain its autonomy. There are various ways in which this could be achieved. License fees seem to provide broadcasters with a stable source of income. But legally imposed fees tend to remain unchanged in the face of inflation and, under usual circumstances, do not provide a satisfactory solution.

Part of the broadcasting revenue may come directly out of the government budget. In the United States, where this is the case for the fourth network, there is currently a lively discussion on how to protect broadcasting funded by the government budget from congressional pressures. A proposal which may be adopted provides for three-year funding, with Congress voting each year on the appropriation for the year three years hence. Since control of events three years in the future is not likely, this scheme would minimize the risk of political interference. To meet the problem of unanticipated inflation, the formula for broadcasting revenue could be related to a fixed percentage of the national budget or to those components of the national budget relevant to communication. But a system fully supported by the government runs the great risk of becoming boring, and reflective of the tastes and views of the civil service. There is no incentive to attract audiences since the revenue does not decline if the audience falls off, and the only people who must be satisfied are those who hold the purse-strings.

A broadcasting system fully paid for by advertisers, on the other hand, tends to produce mass entertainment exclusively since entertainment programs have been shown to achieve much higher audiences than any other offering. Advertisers are not interested in the

intensity of viewer enjoyment as long as the viewer watches at all. Even when faced with competition on the air, an advertiser is not prepared to double or triple production budgets to gain a few extra audience percentage points. In the United States he restricts himself to what can be done for about 2 cents per hour per viewer.

The viewer may be willing to pay substantially more if he feels he is getting his money's worth, and may be prepared to subscribe to pay-by-the-show schemes for the sake of quality programming that meets his particular taste. Collecting from the audience program-by-program involves, of course, some additional costs. A scrambling and unscrambling device has to be used, along with record-keeping. This is technically much easier on a cable system than over the air, although the latter is also feasible. Such a device is not necessary where customers pay a flat fee by month or year, as for example paying a license fee at the post office. But under such a system the customer loses his influence over programming. The broadcaster is in control of what is offered and the viewer must accept it. Besides, in a country whose population is not affluent, the fee may slow down TV penetration.

The choice between having payment by the public, the advertisers, or the government is partly a function of who can best afford it. In a poor developing country multinational corporations that wish to advertise may be the readiest source of funds. A pay-by-the-program system requires the potential customers to be reasonably affluent. In some countries the greatest concentration of wealth is in the hands of the government.

The best solution is probably a mixed system, part of which is responsible primarily to audience tests and thereby provides a standard of comparison as to audience receptiveness, part serves primarily government objectives, and part is purely commercial. With broadcasting deriving its revenue from a variety of sources it is important that a substantial portion of the revenue be for general purposes not tied to the special interests of the sponsor. If each government agency--each university, for example--supports programs exclusively in a particular field such as education, health, national culture, etc., and inadequate resources are provided for unsponsored activities, distorted programming will result.

Internal Organization of the Broadcasting System

Just as there is no single formula for the overall structure of a broadcasting organization or its relation to other authorities, so there is no single formula for its internal structure. That depends on the practices of the country, the past established traditions of the organization, its stage of development, and what makes the people who are doing the job feel comfortable. If there is any one guiding principle it is that broadcasting is a creative activity which must

allow scope for a variety of approaches and pluralism of initiatives to avoid the ossification that arises from traditional bureaucratic structures.

Of great importance is decentralization in the broadcasting organization--and not necessarily or exclusively on a geographical basis. There may be functional divisions with each unit responsible for different types of programming, e.g., educational or ethnic. There may even be separate units set up with no clear difference in their characteristics for the explicit purpose of promoting a spirit of competition among similar but independent creative groups. Regional distribution of creative and production activities remains, however, the most important form of decentralization. It serves to overcome the serious problem of gigantism in primate cities which draw to themselves all intellectuals and persons of ability. Geographical decentralization of broadcasting is also important because state and local authorities need access to broadcasting just as much as central authorities do. In education, public health, business enterprise or government the echelons which deal directly with people are those at the local level. Local school authorities, local merchants and local officials must reach people directly. It is they who can make the most and best use of broadcasting for social purposes.

[Extracted from Chapter 6 of Communications Policy for National Development, Editors Majid Teheranian, Farhad Hakimsadeh, Marcello L. Vidale, published by Routledge and Kegan Paul, London and Boston.

A Multinational North-South News Agency

Roger Tartarian

[This article surveys briefly the main issues involved in the differences arising in UNESCO and elsewhere over the treatment of Third World news in the major agencies: Associated Press (AP), Agence France Presse (AFP), Reuters, and United Press International (UPI). It then reviews some of the current proposals for remedy, and concludes with the author's proposal for a joint venture in news gathering.]

This paper seeks to move the debate over imbalances in the international flow of news and information into a consideration of specific ways by which they might be corrected or minimized. It is based on an assumption that there is a fair measure of agreement in both the developed and developing countries that such a problem exists, and that remedies should be pursued in a cooperative vein. Specifically, this paper suggests a study of the feasibility of an operational linkup between some of the principal news agencies of both worlds, so that at least a limited start can be made toward achieving better coverage of the developing world in both the first world and the third world news media. A suggested point of departure is the concept of a multinational news agency that would: (1) be directed jointly by professional journalists from both areas, and (2) serve as a central production and distribution mechanism for news of social, economic, cultural and other development activities in the Third World.

Before considering a more detailed outline of this concept, it is well to review what is meant by some of the widely acknowledged problems in news flow, and to

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confront the hard political and economic realities which exist in the world of news and information and which must inevitably dictate the limits of practical cooperation. Third World criticism of the present international news flow ranges in tone from scholarly to shrill, and includes charges that the western-based news agencies in particular are engaged in deliberate attempts to make young or developing countries look corrupt or inept. Some of this is rooted in emotion fed by the legacy of colonial history. But there is validity to some of the criticism; it would be wrong to try to dismiss it as a manifestation of national paranoia.

Perhaps one of the most reasoned and succinct presentations of the Third World indictment was presented in the 1977 New York conference on the Press in the Third World convened by the Edward R. Murrow Center for Public Diplomacy, a unit of Tuft University's Fletcher School for Law and Diplomacy. The presentation was made by Narinder K. Aggarwala, an Indian journalist serving with the United Nations Development Programme in the Pacific. He said:

> "The Third World's complaint against the international news media is two-fold. First, that only a quarter of the news that goes on the wires of the four major Western news agencies emanates from, or deals with, the developing countries, although they constitute nearly two-thirds of humanity. Second, most of the Third World news is negative and deals with such subjects as shortages, famines, natural disasters and political and military intrigues. The news disseminated by the four transnational news agencies is meant primarily for the users in the developed countries and has a very strong Northern orientation. What the developing countries want is world news by Third World journalists for developing country media use. There is a genuine need for creating a channel through which developing nations can get news about each other, and the industrialized world, from their own perspective."

There is a temptation for some in the west to isolate comments such as Aggarwala's references to "political and military intrigue" and treat them as an implicit Third World demand that the western media stop reporting such events. Obviously, the western media could never accede to such a demand. But more to the point, no such demand is made by the more reasonable critics in the developing countries. What they ask is that the western media, and particularly the western news agencies, not permit fascination with the spectacular or the aberrant to blind them to progress that is achieved more quietly and unspecatacularly in these emerging societies. Moreover, they say, even if your more important subscribers in developed countries are uninterested in our progress, we in the Third World are interested in each other's--and you are reporting it sporadically at best.

There can be no substantial quarrel with these general conclusions about the state of international news flow:

--There is, in fact, imbalance in the flow of news, both in content and in volume, since there is more of it in one direction--moving from the developed to the developing worlds, or, as some commentators put it, from the North to the South, and much less from South to North. It is true that this reflects the relative distribution of global military, economic and political dimensions, but that does not alter the truth that the news imbalance exists. The disposition of news agency staff correspondents around the world indicates where the emphasis of coverage is. AP and UPI probably have more fulltime staff in their London offices than in all of Africa. Reuters and AFP outstaff the American agencies in Africa, but Reuters and probably AFP have more regular staff in the United States than in all of the continent of Africa.

--There is great disparity in the quality and quantity of regional coverage provided by the western agencies of and to the Third World. While Latin America is relatively well covered for the Latin American press, it is not covered as well as is Western Europe. Even so, it is much better covered for regional news than is Asia, and immeasurably better than Africa.

--Agency coverage often tends to seek simplistic solutions, or Cold War ramifications, in situations that are typically Asian, African or Latin American. For example, labels like "anti-American" or "pro-Soviet" can and do mislead when applied to many Third World situations. This can be attributed to institutional rather than ideological attitudes. Regardless of nationality, news agency journalists of all kinds understanably tend to adapt writing styles, choice of "lead" material--indeed, an entire definition of what is "news"--to conform with what they find dominating the wires of their agency. This results in a homogenization by which subtle nuances that are of extreme local importance become levelled out in the interests of distant readers.

--There is an acknowledged tendency among western media, including the news agencies, to devote their greatest attention to the Third World in times of disaster, crisis and confrontation. The agencies are no less interested in disaster, crisis and confrontation when it occurs in the developed world; but their daily file of news of the developed world is vast and variegated, even when there is no crisis. The same is not true of much of the Third World coverage. Staff correspondents are airlifted in to cope with an emergency and depart when it is over. Coverage then reverts to the status quo ante which means, in many or most places, that coverage is left to part-time local journalists or "stringers".

What Third World journalists feel to be especially lacking on the wires of the Big Four is what can only be called news of national and regional development--news acquainting each other with their efforts toward economic, social and cultural progress. This would call for a somewhat different concept of "news" for the big agencies. The international services of the Big Four, for example, are not likely to report the opening of a new cotton processing plant in the southern United States because it does not fit their traditional definition of international news. It is too parochial, too much local fare, for the foreign correspondent. But the same yardstick applied to the opening of a new peanut plant outside Niamey, Niger, can result in a feeling that the agencies are uninterested when there is "positive" news to report from a Third World country. To an editor in Nigeria, the new plant in Niamey could be very significant news indeed, and the failure of the major news services to provide it simply fuels the criticism of their work.

Non-Aligned News Agency Pool

In 1976 the Non-Aligned News Agency Pool was established by some 85 developing nations to help fill this informational need. There is no evidence yet that it is having any major impact on the flow of news between the participating countries, partly perhaps because its participating national news agencies are themselves largely dependent on the Western wire services for news about their neighbors. An American analysis of the Pool's work during the first quarter of 1977 found that 60% of the news carried by the Pool was provided by just seven countries--Yugoslavia (which operates the Pool's transmissions), 17%; Egypt, 12%; Iraq, 7%; and Cuba, Libya, Sri Lanka and Qatar, 6% each. But even granting that participation is expected to increase, there is some question whether the Non-Aligned Pool can have more than peripheral effect on the international flow of news. In his paper to the Murrow Center conference last year, Aggarwala said, inter alia:

> "In its present form, the (Pool) agreement, for all practical purposes, provides for no more than a mechanism for exchanging official information on news handouts. Its usefulness, other than as a first step measure, is questionable since participating governments are unlikely to force their media to publish news received through the Pool whose credibility they themselves doubt, or whose contents collide with their own or their allies' policies."

This political aspect of the Non-aligned Pool cannot be neutralized. It is inherent in the concept. What the Libyan agency ARNA chooses to send to the Pool, for example, may or may not be what would most

interest the readers of Al Ahram in Cairo. That problem can be multiplied by as many times as there are frictions between governments.

The Pool nevertheless represents a positive step in the effort to increase the international flow of information. What governments say to each other or their own people, or the way they view developments at home and abroad, constitute an important ingredient of news. But it is only one of many ingredients, and needs to be kept in perspective. None of this is to suggest that the Nonaligned Pool is incapable of distributing anything that meets the broader definition of news--it can, and it does. But its efforts are clearly having no great impact on international news flow, simply because they are not finding their way into the world's major news streams.

The Big Four News Agencies

What is equally clear is that this activity would be more effective if it were done in a broader international context in a pattern of cooperation with the major news suppliers of the world. It is here, in seeking to develop this pattern, that hard political realities must be confronted--realities that dictate who can and cannot be expected to be partners in such a venture. It is highly significant that, in his appraisal of the work of the global news services, Narinder Aggarwala speaks of "the four" international news agencies that are in fact the major suppliers of news to newspapers and broadcasters of the world today: The Associated Press and United Press International (United States), Agence France Presse (France), and Reuters (Britain). There are, of course, other large information organizations in the world. But on one of two tests, they differ from the Big Four in very important ways. Some, like West Germany's DPA or Japan's KYODO, are excellent, broad-coverage news organizations but lack the geographical spread of the Big Four. Or they are geographically as widespread, as in the case of the Soviet Union's TASS or China's HSINHUA, but are so organically a part of a political state that they are institutionally incapable of distributing news critical of their governments or their allies. The western Big Four agencies are hardly perfect entities, but they do have the ability to transmit news even when it is critical of their governments and public leaders. Even more, they can, and do, initiate such news through their own investigative reporters.

The importance of the Big Four to governments at large can be illustrated by the fact that their news teleprinters can be found in most Foreign Offices of the world. The TASS teleprinter can perhaps be found as often, but not as often for the same reason. TASS is an excellent source for obtaining a Soviet viewpoint; but it is not the best place to learn that the People's Daily in Peking has devoted its entire front page to an attack on Soviet revision-

ism, or that Al-Ahram in Cairo has criticized Soviet policy in Africa. The western agencies have no difficulty in comparable situations because they are news agencies in a different sense and not official information organs. This distinction is a vital one because it is the key to credibility, and credibility is the most important asset that journalistic enterprises can possess.

The Issue of Government Control

This distinction between news and official information also explains the bitter division with UNESCO over the controversial Soviet draft resolution on the "uses" of the mass media by government. The discordant philosophies within UNESCO only foredoom efforts to find a universally acceptable plan to reorder the flow of world information in keeping with the instructions of its General Conference in Nairobi in 1976. The first meeting in December 1977 of UNESCO's International Commission for Study of Communications Problems reflected the virtual impossibility of the task handed it by the Nairobi conference. It was clear from the opening moments that "free and balanced flow of information" meant quite different things to different countries. And after UNESCO Director-General Amadou-Mahtar M'Bow exhorted the delegates to pursue the UNESCO goal of a "new world information order," the chairman of the conference suggested that the delegates first try to agree on what is meant by "new information order," a call that has resounded in UNESCO literature since 1974 despite its apparent ambiguity. UNESCO has become a suspect midwife in the eyes of many western journalists who, rightly or wrongly, are convinced that its staff and its experts are ideologically wedded to fostering state control over media, even where independent systems can exist. Whether or not that is the case, the prospects for UNESCO to provide a solution to the present problem is, by any realistic assessment, dismal at best because of the clashing philosophies of its members regarding control of news.

There can be said to be three types or degrees of control in the world today:

1. Maximum Control: Exists where information media are exclusively state-owned on a permanent, constitutional basis. Regulation of speech and press embraces the entire spectrum of human activity--that is to say, comments about art, literature, music, dress, sport, etc., are as rigidly subject to central authority as are comments about political issues. The Soviet Union and China would be models in this group.

2. Limited Control: Exists where media can be either state-owned or privately owned but where restraints on expression are

largely political. This would apply to much of the Third World and includes places such as Nigeria, the Philippines, etc. where constitutional provisions for a free press are for various reasons suspended by emergency decree, but which remain as long-term objectives.

3. Minimal Control: Exists where the media are exclusively or overwhelmingly independent of government and where limitations on expression are at the lowest of existing levels. Models here would be India, the United States, most of Western Europe, Japan, etc.

It is not only these philosophies that confront UNESCO in its efforts to define such things as "balanced" or "free" flow of news and information. It must also respect the desire of some member states to keep their societies closed to all but rigidly controlled scrutiny from outside, a desire that collides head on with the goal of the western media for free access. The net effect of all such factors is to indicate that the second and third groupings above offer the best possibilities for a measure of cooperation on news and news flow. As limited as this might be, it at least represents the basis for starting a search for remedies in an area where action seems to be overdue.

Technical Assistance In Communications

There has been some response in the developed countries to the communications problems of the Third World. An important initiative has come from the World Press Freedom Committee, an organization that was founded in 1976 as a joint project of the Inter-American Press Association and the International Press Institute, and which now has some 30 affiliates in the Western Hemisphere, Europe, Australia, Hong Kong and Japan. Led by George Beebe, Associate Publisher of the Miami Herald, and other leading American journalists, this group through a special development committee is raising $1,000,000 to provide technical assistance to Third World media. Its initial grants have included $20,000 to the University of Nairobi School of Journalism, $10,000 towards a reporters training school in Trinidad; and $10,000 for a seminar to train African journalists in economic and financial reporting. As excellent as this project is, however, it does not touch the central part of the present problem: the dissatisfaction in the Third World with the present international news flow as it is provided by the major suppliers, i.e., the Big Four western-based news agencies.

Spokesmen for AFP, AP, Reuters and UPI have repeatedly expressed a readiness to help the various national agencies on a bilateral basis with such things as exchanges of news and training

of staff, but they emphasize that it must be on a commercial basis. They themselves lack the resources to finance assistance projects of that kind. Nor can they expand their own coverage of Third World subjects to any appreciable extent in areas where they cannot generate new revenue to cover their costs.

The dilemma of the western agencies is reminiscent of the situation facing the American media for many years with respect to coverage of U.S. national elections. Historically, AP, UPI and the three U.S. television networks each covered the entire country on polling day as well as it could with its own resources. (There is no central official vote counting mechanism in the United States; it is the media that proclaim the winner on election night.) But none could afford to cover the entire country very well by itself. They finally agreed in the mid-1960s to pool funds and have only one large vote-counting apparatus where five lesser ones had always existed. The result was a dramatic improvement, which none of the five partners could possibly have financed itself. It would be impossible, however, to apply that consortium principle to the present situation, even it it were desirable--which it is not. Competition does provide checks and balances, and cartel-like arrangements have their own perils. In any event, the four western news agencies are too sharply competitive, too fiercely independent to consider such joint coverage, even in news-deficit areas. What remains to be explored is whether there is any way to draw them into a cooperative venture with interested Third World agencies without affecting their competitive operations or compromising their independence.

Meanwhile, coverage of much of the Third World remains both sparse and fragmented. The creation of the Non-aligned News Pool has added to the total news potential in the region, but it works in isolation from other entities. Clearly some sort of operational linkage between the western and Third World agencies would be to the benefit of all concerned.

Third World News Agency - A Plan

The element of linkage is missing in an otherwise interesting plan for a new Third World News Agency (TWNA) presented to the 1977 Murrow Center Conference by Narinder Aggarwala. His concept was for an agency that would be "truly multinational in operations, management as well as staffing, free of domination--not only of the governments but also of any of the national news agencies." Aggarwala's outline calls for a more elaborate international mechanism than that of the present Non-aligned Pool. In addition to receiving the output of the various national agencies, the TWNA would have its own offices in major news centers such as New York, London, Paris, Moscow, Geneva, Peking, etc.

The present Non-aligned Pool is highly centralized; most participants send their contributions to the Yugoslav news agency TANJUG in Belgrade for relay on its radioteletype circuits to appropriate areas of the Third World. Aggarwala foresees three TWNA regional centers, each with multi-lingual translation capabilities. The regional center would receive dispatches from both the TWNA international bureaus and the various national agencies for appropriate relay. As a double check on the work of the national agencies, the regional centers of TWNA would have their own "national" bureaus in each country. National Bureau chiefs would be non-nationals of the country to which they were assigned, a precaution against the pressures that nationals are inevitably subjected to. "The (non-national) bureau chief will be one of the most important functionaries in the TWNA setup," Aggarwala wrote. "He/she will be responsible for building up the credibility of the TWNA as a news disseminator by weeding out unreliable or unverifiable material from national news agency dispatches."

Aggarwala would have the TWNA concentrate at first on serving the media of developing countries. "In that sense," he says, "it will not change the Third World coverage in the Western media. However, as the TWNA builds up its services and establishes its uniqueness, credibility and reliability as a news disseminator, it is likely to attract subscribers from the developed countries." He does not indicate either the source or the extent of the funds needed to turn the TWNA concept into a reality, but there can be no doubt it would require an investment much greater than the costs of the present Non-aligned pool.

Agency development within the Third World is uneven; and the basis for the functioning national agencies required for Aggarwala's TWNA concept may take time to evolve. Biola Olasope of the Nigerian Broadcasting Corporation indicated the extent of the problem in a paper presented to the Murrow Center Conference in 1977. Far from having correspondents in more distant power centers, he said, the few African countries with national news agencies "do not even have correspondents in other African countries...Lagos, the capital of Nigeria, is a major power center within the African context, but no African news agency maintains an office there at present. The reasons for this unsatisfactory situation are simple. African countries lack the funds, trained personnel and facilities needed for setting up and operating an international network for gathering and distributing news."

In any case Aggarwala's TWNA blueprint is there for consideration by the Third World. More within the realm of present possibility would be a joint venture by Third World and western media in a way that would utilize existing news collection and distribu-

tion facilities and provide, at far less expense to all concerned, a new dimension of Third World news on a basis of cooperation rather than competition.

Proposal for a Multinational North-South News Agency

It is suggested that a joint study be made of the feasibility of forming what, for illustration's sake, will be referred to here as the Multinational News Agency, one which would represent a joint North-South venture in news collection and dissemination. Some possible guidelines for its organization and operation follow:

1. The purpose of the Multinational Agency would be to provide on a cooperative basis the type of news reportage now felt to be missing in the Third World. It would avoid day-to-day "hard" news, especially concerning national or international politics, which is more properly the function of existing news sources. Instead, the Multinational Agency would place its emphasis on the projects and programs in the Third World for economic, cultural, industrial and social development. Its goal would be to supplement existing sources by reporting on activities that rarely make headlines but which are nevertheless of great interest in many places. It would strive to provide well-rounded reportage, that would neither ignore "problems" where they exist nor concentrate on problems to the exclusion of all else. On the basis of what is known of the news now coming out of the Third World, the Multinational Agency would seek to provide the missing dimensions.

2. Participants in the Multinational Agency would be drawn from among the membership of the Non-aligned News Pool on the one hand, and on the other, from press organizations represented directly or indirectly by the World Free Press Development Committee (i.e., the developed countries).

3. Interested elements from each grouping would organize the Multinational Agency around a 12-seat Directorate representing the press of the developing (South) and developed (North) worlds on an equal basis.

4. A beginning might be made with the participation of media representatives of the following countries: South - Egypt, India, Mexico, Kenya, Nigeria and the Philippines; North - Sweden, Japan, West Germany, United States, Britain and France.

5. Membership in the Directorate would be limited to professional journalists of the highest level. No country would be allowed more than one seat.

6. The Directorate would assemble a corps of special reporters for the Multinational Agency by asking, first, the principal news agencies, and second, the major newspapers of each grouping to loan it the services of one experienced correspondent for a fixed period, certainly not less than one year.

7. The salaries of correspondents seconded to the Multinational Agency would be paid by their regular employers as their contributions to the joint enterprise. Their expenses would similarly be underwritten until such time as the Directorate could obtain alternate financing. Since no agency or newspaper would be asked to provide more than a single correspondent, the cost for each participant would not be heavy.

8. For practical purposes, the Multinational Agency's staff could be limited at the outset to 8 to 10 correspondents from each of the two groupings, giving it a total corps of 16 to 20 seasoned correspondents--still an impressive number. The numbers could be increased as time goes on.

9. Because of their special role in the realm of international news, the Big Four western agencies would function as a permanent source of correspondents for the Northern side, as might West Germany's DPA and Japan's KYODO. Once agency members were recruited, the Staff to be provided by each side would be rounded out by requesting the loan of other correspondents from individual newspapers, always on the same economic basis.

10. Correspondents seconded to the Multinational Agency would work under journalistic supervision provided by the Directorate. Each correspondent would specialize in coverage of a given country or countries and would be based in one of those countries. In no event would a correspondent be assigned to his own country. The desired effect would be, for example, an Indian journalist covering a Nigerian event for the rest of the world, or a French journalist covering an Egyptian event.

11. Dispatches written by the correspondents would generally be airmailed to a central distribution office to be designated by the Directorate. The dispatches would be made available simultaneously to all participating agencies. Because of already existing exchange agreements among world agencies, these dispatches in this way would also reach TASS, HSINHUA, etc. and others not directly represented in the Multinational Agency.

12. The Big Four western agencies might provide use of their global communications facilities to correspondents of the Multinational Agency on those limited occasions when it was felt a dispatch could not await delivery by air.

13. The Multinational Agency would not affect the competitive operations of any established news agencies in any area. Since all would get the output of the Agency simultaneously, none would be disadvantaged by its operations.

14. Funds necessary to operate the Multinational Agency would be obtained by the Directorate from participating countries of both North and South. Limits might be set on the national contributions to prevent any domination of the operation. Contributors would raise funds in their own characteristic and preferred manner. Private, non-government monies would be preferred by some participants; for others, there would be no alternative to government monies.

15. The Directorate would select one of its members as Chairman. It would establish a headquarters office on the premises of an existing journalistic organization in some large Third World center where most major news agencies are represented. This would house the skeleton staff needed by the Multinational Agency itself.

16. The working staff of the Multinational Agency would consist of a Managing Director and three deputies chosen by the Directorate. They would be posted in the central office to direct the work of the special correspondents and ensure the widest possible distribution of their reportage.

17. For an initial period at least, the Multianational Agency would operate in English as the language most common among the participants. This would not and must not bar non-English-speaking journalists from being assigned to the Agency staff. In their case, dispatches would be sent first to their own home offices for translation before being forwarded in English to the Multinational Agency for general distribution.

18. Once established, the Multinational Agency could serve as a central clearing house or a natural bridge for other forms of cooperation between First and Third World journalists. The Directorate could be authorized to accept grants from governments as well as private sources to finance exchange programs and scholarships for training of journalists and sharing in technologies.

19. By its very nature, the Multinational Agency will itself provide an important training function which should help to eliminate what Third World critics frequently perceive as unconscious bias in western reporting on the developing countries. The day-to-day cooperation and consultation among members of the Directorate and its staff can result only in greater understanding of those deep-running differences of culture and language which more often than not are the true explanation of alleged bias. Moreover, the constant movement of correspondents of different nationalities in and out of dif-

ferent countries will foster cross-cultural transfers of knowledge and background and thereby produce increasingly perceptive and sophisticated reportage. As correspondents complete tours of duty with the Multinational Agency, they will take with them broadened cultural perspectives that can only make them better correspondents, no matter where they are next assigned by their regular employers.

20. In its commitment to fair and well-rounded journalism, the Multinational Agency would seek to promote the concept of open access to news in the international sphere, and to minimize obstacles to the movement of reporters across national boundaries.

What must now be determined is whether this basic concept is considered feasible by the potential participants. There are certain to be reservations and hesitations on both sides. The outline is admittedly limited in scope. And yet, the utter unlikelihood that any alternate global formula can be found, even in the remote future, would surely suggest that a solution by stages is the most realistic way to make a beginning.

What cannot be emphasized enough is that the Multinational Agency would in no way undercut, conflict with or otherwise affect the workings either of the Non-aligned Pool or any of the other agencies concerned. All would continue their regular activities in the ordinary way. The Multinational Agency would simply provide a limited superstructure that would do two things: (1) provide for the joint production of a dimension of news now widely acknowledged to be in short supply; and (2) provide a central point for other types of cooperation between important elements of North and South, including training programs, sharing of technical knowledge, and the solution of common problems on a cooperative basis.

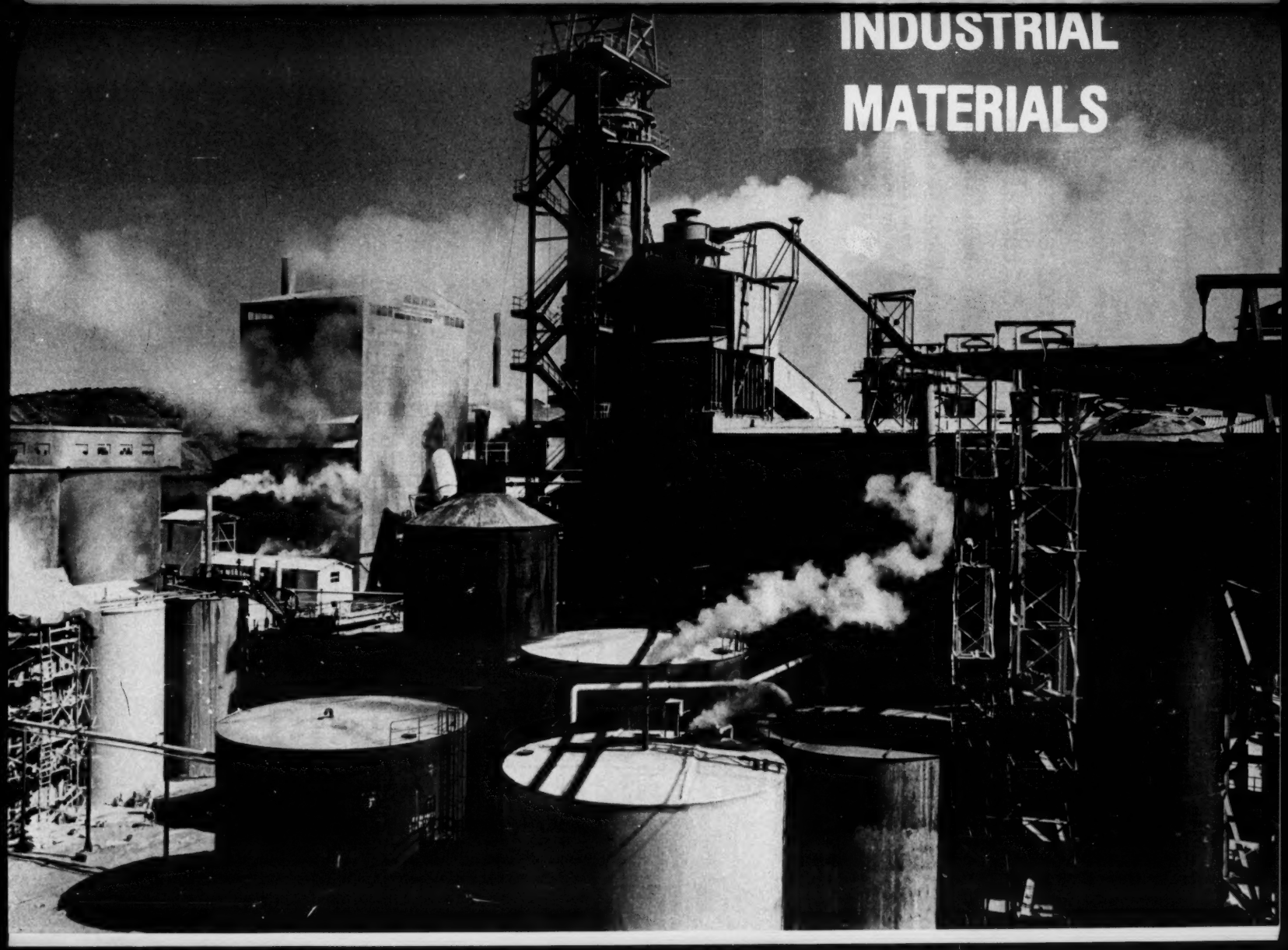
The detailed mechanics for an enterprise of this type could be worked out without great difficulty if the basic idea were found acceptable. A vital requisite would be the acceptance, particularly by privately-owned western media, of the concept of mixed private and governmental funding. This is a point that must not be glossed over because it is crucial. Any Third World financial support of the Multinational Agency would of necessity come from national treasuries, since news agencies in developing countries are, without exception, dependent on official funding to some degree. This involvement by government with news media is more a matter of sheer necessity than of preference or ideology. The circulation and advertising bases needed for the operation of financially independent media simply do not exist in most of the Third World. Their real choice, therefore, is not between free media and government-controlled media, as some commentators seem to believe, but between government-controlled media and no media at all.

Those who issue blanket indictments of government involvement with news media anywhere, and under all circumstances, are in reality sentencing millions to indefinite periods of informational poverty. When there are no other options, a press founded and controlled by government surely is better than no press at all. As economies develop and literacy grows, such a press at least provides a base from which a more independent system can evolve. The cooperation of western media in something like the Multinational Agency would help encourage such a metamorphosis in places where there is still no irrevocable commitment to the Soviet model.

Inherent in the mixed nature of the Multinational Agency is the mechanism for allaying the historical fears of some western media, particularly the American, of any financial dealings with governments, especially their own. The intermingling of monies from all sources in a multinational treasury would preclude any basis for suggesting that any one participant was subsidized by any one government. Moreover, no official monies would go to any individual agency or newspaper. All would go directly to the Directorate for payment of the few headquarters salaries and, eventually, the expenses of the pool correspondents, whose salaries would continue to be borne by their employers.

This arrangement makes it possible for governments of developed as well as developing countries to contribute to the Multinational Agency, within limits which would be established by the Directorate to prevent financial domination by any one donor. The question of government finance is emphasized here because it is extremely unlikely that private initiatives such as that of the World Free Press Development Committee can alone mount or support a program that could have any real impact on the international flow of news. In any study of the feasibility of the Multinational Agency concept, the first question to be answered is whether this form of mixed funding is acceptable. If that problem can be overcome, the task of developing a more detailed blueprint for a Multinational Agency becomes immediately less difficult.

[Extracted from a paper prepared for a Conference on the International News Media and the Developing World, Cairo, April 1978, sponsored by Cairo University's Faculty of Mass Communication and the Middle East News Agency. Reprinted as an Occasional Paper of the Murrow Center.]


INDUSTRIAL
MATERIALS

THE LAJA CHEMICAL
PULP PLANT NEAR
CONCEPTION, CHILE
(PHOTO: BY RAY WITLIN FOR
WORLD BANK AND IFC)

Materials: Some Recent Trends and Issues

Hans H. Landsberg

[This article reviews briefly the arguments and the evidence on the probabilities of exhaustion of world materials supplies, and the prospective effectiveness of several ways of adapting to greater scarcities.]

Man has always been preoccupied over tomorrow's supplies. While immediate needs are perhaps less in question now, the dynamics of growth have enormously broadened the scope of concern. Once provisions of minimum food and shelter needs have been assured, growth has meant added ways of occupying one's time and most of these invove the use of *materials*. For this discussion, materials comprise basically the nonenergy minerals, forest products, fibers and those chemicals not already covered; excluded are food, energy sources and drugs. What we wear, move on and in, live, sit and lie in, use to fashion tools, simple and complex, or need for modern entertainment, recreation, education, and much of the healing arts, all this incorporates materials as defined.

Depletion and Adequacy

The volume and variety of materials used in modern society have grown steadily. The rise in aggregate consumption has given birth to two ideas. One is the opinion that materials exhaustion could bring civilization tumbling down. The other is a rather widespread opinion that the advanced societies are "moving away from goods to services" and will continue to do so. A gradual reduction in the rate of growth of materials consumption, and eventually perhaps in consumption it-

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self, would follow. There is yet a third group of theorists who point to mankind's past success in overcoming the threat of scarcity as grounds for believing that we are neither threatened by exhaustion, nor must we seek salvation in a transition to a service-oriented economy. Instead, reliance is put on more efficient ways of gaining materials in conventional environments, of identifying new environments and new materials, and proceeding to more efficient use and reuse of materials.

The battle among these groups has swayed rather indecisively. The impact made by the *Limits to Growth* school (See Development Digest, October 1974, pp. 3-43) has been massive, especially in some European countries that have traditionally been materials-poor. Stripped of the moral and emotional overtones that often accompany the main theme there remains a core of insight to the warnings; this core deserves serious consideration when appropriately formulated. Brooks and Andrews point to the declining usefulness of distinguishing between renewable and nonrenewable (finite) resources. They caution, however, that the rub comes in managing the extraction and processing stages, because the effects of earth-moving and other disturbances of the environment present increasingly difficult and costly obstacles that can overwhelm the task of supplying rising quantities of desired materials, and may constitute the real limits to growth.

Companion arguments focus on the relative magnitude of the earth's unexplored and explored portions, on the ocean bed as a future technologically feasible supply base for at least half a dozen metals, and the known, very large occurrences of a few minerals--such as iron, aluminum-containing ores, silicates, carbon, titanium and magnesium--on which could be based, if not an exact replica of today's society, a reasonable variant thereof. While as yet little explored, the building of credible scenarios incorporating severe constraints with regard to the availability and variety of materials could usefully illuminate this particular issue, sometimes dubbed "the worst case" approach. The point is not to stress the fact that mankind once existed with a small fraction of our materials supply, so why couldn't we; but rather it is to inquire, knowing what we know now, to what extent, in what direction, and at what cost a greatly restricted materials menu would force us to modify our way of life.

A recent entry is the idea that, given sufficient low-cost energy, the materials problem tends to disappear as energy becomes a substitute. Consequently, the emphasis shifts to the limits set for energy consumption, by way of heat release or other accompanying circumstances of energy production and consumption, that counsel at least prudence.

By and large, the adequacy debate seems at a standoff. The *Limits to Growth* approach no doubt has increased our sensitivity to

the depletion issue. At the same time, the bigger-than-life dimensions of the model have limited its usefulness to policy-makers and increased the number of objections based on its mechanistic framework and its neglect of important variables that could be assumed to be operating in the early portion of the time span of the *"Limits"* model. In contrast, no technological breakthroughs have occurred of the kind that would give the argument that depletion continues to be shifted forward in time a winning edge, nor has there been a breakthrough, for example, in seabed material recovery, or a switch to new abundant mineral resources in, say, the aluminum area, or in recovery methods, such as leaching as opposed to excavation. No wonder that proposals to engage in a systematic drilling exercise to "inventory" world resources have found some enthusiastic supporters, especially among geologists.

Goods versus Services

Perhaps there is a way out if we are indeed slated to develop into a world where production of goods is rapidly giving way to production of services, as in the more industrialized countries. With demand diminishing, first in its rate of growth, then absolutely, the opportunities for clashes of competing objectives would equally diminish. It is, therefore, useful to review the nature of this phenomenon, sometimes referred to as the "post-industrial society." But the concept is somewhat at variance with the facts. To begin with, the so-called service industries are in part quite material-intensive: transportation and utilities are good examples. Consumer expenditures for services in the U.S. National Accounts (as opposed to service industries) involve heavy materials use, extending to such apparent nonmaterial categories as recreation, medical services, entertainment, and others as practiced in our society. To illustrate, a couple of years ago I sorted out the appropriate categories in the 1970 National Accounts. I found that, of an estimated $39 billion of consumer expenditures for recreation, fully 17 consisted of durable goods and 11 of nondurables, while only the remaining 11, or less than one-third of the total, were classified as "services" proper; even portions of this last category may in turn contain a quota of materials.

Nor, contrary to impressions sometimes gleaned in the media, has the U.S. gone very far in the "turn to services." Only when shifts in employment are considered do we find a significant trend to services: from 56 to 68 percent of total employment in the two decades ending in 1970 (a large part of this change reflecting the decline in agricultural and the growth in government employment, especially in education). In contrast, services grew only from 34 to 38 percent of total consumer expenditures during the same 20 years; and the share of the so-called service industries (a fuzzily defined category) went from 60 to 63 percent of the gross national product (GNP), corrected for inflation.

If the record of the past two decades renders it questionable to count on a reduction in the rates of the use of materials because the service sector will grow at the expense of the goods sector, this is not to say that such rates need to continue at their historic trend. There are other ways in which materials use may be reduced. Some authors like Malenbaum and Brooks have attempted--mostly for metals--to systematize this reduction by postulating materials-intensity factors that decline with rising per capita GNP. The idea is seductive, even though the statistics adduced lack a description of underlying process and motivations. Students of U.S. energy history are reminded of a parallel in which, over a period of some 100 years, the ratio of per capita energy use to per capita GNP first increased, then flattened out, and then declined. In the case of materials, this phase of research remains to be tackled.

In the absence of a common measure of materials use--other than a monetary unit--the thesis so far rests on historical trends and projections for single commodities. Substitution effects thus cannot be isolated. Over extended periods in which materials of petrochemical origin, for example, have risen with extreme rapidity, one would like to test the hypothesis for materials in the aggregate. Such an effort would assess, for example, whether a country passing through a heavy capital goods investment phase, including construction of major transportation networks, public facilities, and the like, is especially materials-intensive; it would examine how far improved efficiency in use plays a role, as economies mature; and whether, as suggested above, the trend is toward newer materials, imparting to the old standbys--such as iron, copper, lead and zinc--a downward momentum, which may be misread as a general "law." In the meantime, it is probably prudent not to look to the possible existence of such long-term relationships--an intensity rise and decline law--as offering a way out of contemporary problems associated with materials production and use.

Materials Extenders

Recycling and substitution are the two "magic" terms that suggest more immediate escapes from scarcity, and are on everybody's agenda of remedies. Although neither is new, knowledge for judging the opportunities they offer is scant. Recycling has been given a new momentum. But at the same time, we have become aware of the obstacles to recycling or reuse, some of them institutional, some technological, and some economic, that is, cost-associated. Estimates of the potential contribution to the total materials supply by mobilizing after-use streams or stocks of materials depend on assumptions regarding the estimated length of the useful life of the product, efficiency of the gathering mechanisms, recovery efficiency, characteristics of the recovered material in relation to the specifics of demand, and public policies designed to affect the incentives for increasing efficiency all along the line.

As the result of an attempt a few years ago to judge what metals might raise the contribution made by scrap if there were an active recycling policy, it was estimated that little in the way of added material could be expected for iron and lead--that is, recycling mechanisms and incentives appear to be working effectively already--but somewhat more for copper, and a great deal more for zinc and aluminum. In the last instance, the relatively recent emergence of the material as a large tonnage item inevitably means that the volume should rise as stocks of obsolete products come increasingly into the market. Given the large energy component in primary aluminum and the relatively small one in the secondary product, the prospect of a rising recovery potential is cheering; but much depends on creating the slope that will enable the secondary material to slide into use rather than disposal. All this is in the future, however. The available statistics reveal no upswing in recycling up to now.

As for substitution, the upheaval in energy prices has upset the once widespread speculation that the more abundant minerals, like aluminum and magnesium, and those derived from oil and gas, would increasingly encroach upon their competitors. High energy costs of both are now an obstacle to expansion; and while their light weight gives them an advantage in some uses (for example, aluminum and plastics in motor vehicles), this must now be balanced against the demerit of a high energy input in their manufacture. Indeed, there has been occasional agitation for deliberately reversing the historical trend and substituting steel for aluminum, solely on the grounds that the former is less energy-intensive. Like most single-purpose policies, this one too suffers from the tunnel vision of its perpetrators. Very sophisticated and specific models would be required to decide which material has some over-all superiority in a societal sense; and social goals no less than private ones are bound to change with changing circumstances, and especially technology. On a more general plane, it requires that we refrain from subordinating or sacrificing total cost estimates to calculations cast only in physical terms.

A more recent suggestion designed to widen the materials horizon has been to consider substituting renewable--that is, biomaterials--for nonrenewable ones. Forest products, fibers, natural rubber, and others are said to merit a new look. The driving forces here are (i) the high price of energy in situations where the fossil fuels constitute the feedstock, supply the needed process heat, or both; (ii) the desire to ease the draft upon depletable minerals; and (iii) the thought that such a turn would be beneficial to some of the developing countries that have in the past lost their markets to synthetic substitutes for their natural products.

The suggestion, or set of issues, cannot be evaluated in any generally valid sense. At some level of cost it may indeed be cheaper

to derive feedstocks for the chemical industry from trees or other plants rather than from natural gas, oil, or coal; or natural rubber may regain part of the market it has lost in the past three decades to the synthetic product. If and when such conditions arrive as a consequence of relative shifts in costs and prices, judgments will have to be made whether these changes are desirable also from other vantage points. Land devoted to growing industrial materials, for example, would not be available for raising food crops. In order to increase productivity, fertilization would have to be greatly increased. Environmental problems are bound to emerge at various processing stages. While one ought to be alert to the opportunities offered by moving along this particular substitution route, comprehensive analysis is in order before facile hypotheses turn into conventional wisdom. It is perhaps worth stressing that forest land is likely to be eyed as potential cropland, as "energy farmland" to produce combustible timber, and as a source of chemical feedstock, quite apart from the traditional growing of timber for forest products. Multiple claims will have to be sorted out and reconciled.

[Extracted from Science, Vol. 191, No. 4227, February 20, 1976, pp. 637-9.

Energy Implications of Materials Processing

Earl T. Hayes

[The energy used up in the processes of converting materials into forms used by consumers or industry (including also energy materials themselves) is very large, and becomes increasingly important as energy costs go up. This kind of analysis, which is relatively new, is shown for the United States; similar relationships and considerations are involved in assessing the situations in other countries.]

Industrialization can be defined as substituting fuel energy for human energy. Chemical engineers have traditionally performed materials and energy balances in their research. Such balances are needed today, as never before, because our accounting for energy consumption must go far beyond knowing that the steel industry consumes 5 percent of a nation's total energy supply, or that to produce one pound of aluminum requires 6 to 8 kilowatt-hours of electricity in the smelting step. Today, energy accounting must be precise and sophisticated, and it must include metallic and industrial minerals, plastics, chemicals, and fuel minerals. The efforts of industry to extract these materials from nature and convert them to useful states requires more than one-fifth of the total U.S. energy budget, for example.

General Approach

The definition of materials used in this article includes fuels as well as structural materials. Thus, in the analysis of amounts of energy required to produce usable substances, the energy, materials, and dollar equivalents are involved. Rigorous analyses of materials processing systems to determine unit energy

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requirements were not done systematically until the last few years. Such evaluations of metals, chemicals, and other commodities are just now coming into the scientific literature.

Each material requires its own analysis development under some broad guidelines. In one methodology, any specific materials analysis covering a commodity must be large enough to include the entire industry of any nation. All degrees of technological progress must be represented in the final output figures. Modern facilities must be taken together with outmoded plants, and their energy efficiencies averaged. For example, zinc recovery systems vary in efficiency from 60 to 85 percent; all operating levels must be included.

Both upper and lower bounds limit energy analysis. In the last 4 years the United States consumed 69 to 73 quads (1 quad = 10^{15} Btu's) annually, and the total energy estimated in particular uses cannot exceed this figure. Data from the Bureau of Census and the Bureau of Mines provide more refined summaries of the total energy expended by specific industries; these values are upper limits for the particular industries. Lower limits include for example, the energy used in the construction of a grinding mill, or the calorific value of human labor. Such data are insignificant in overall energy studies dealing with tens of millions of Btu's per ton of material.

Society must know the energy requirements of all industrial materials for many purposes. The most important are for determining (i) the energy intensiveness of specific materials, (ii) the national requirements for specific materials industries, and (iii) energy flow diagrams paralleling process flow diagrams. These factors help guide the selection of materials. Further, they aid those seeking to conserve energy in present systems and to minimize energy requirements in developing new technologies.

Metallic Materials

Several studies on metals have appeared in the last few years: for example, the Battelle Columbus Laboratories performed a complete evaluation of energy in materials for the Bureau of Mines. Battelle employed basic metallurgical flow sheets, starting with ore in the ground and proceeding through the steps of mining, transportation, concentration, and reduction to the metallic ingot stage. They then assigned energy consuption rates to each step in the flow sheets. Census data, Bureau of Mines surveys of industrial consumption and production of energy, information on industrial operating experience from several sources, and other published information provided the basic energy data. In the Battelle study all energy inputs were converted to a common factor, British thermal units; a value of 10,500 Btu's (thermal) per kilowatt-hour was used for electricity.

Two metals, copper and iron, are of particular interest because of their significance to society. Copper is important because it is such a good conductor of electricity and heat; these properties are essential in an industrialized society. Iron and its alloys are the most versatile metallic materials available to man and are produced in the largest amounts. Without copper and iron no economy could hope to meet the demands of the people.

A simplified flow sheet for processing 1 ton of copper from a sulfide ore containing 0.7 percent copper (near the current average grade) appears below. The average energy consumed in each step, expressed in millions of Btu's, appears in parentheses. The accuracy of the total energy was estimated to be ± 10 percent.

Mining (21.6)
↓
Concentration (42.3)
↓
Smelting (38.2)
↓
Refining (10.2)
↓
Total: Refined copper (112.3)

Some copper is recovered by leaching heaps and waste dumps with sulphuric acid. The process precipitates the copper from solution, electrochemically, with ferrous scrap. A separate flow sheet developed for that segment of the industry shows the energy (10^6 Btu's) needed to produce 1 ton of cement copper.

Sulfuric acid solution
(largely self-generated)
↓
Pumps (41)
↓
Waste dumps (0)
↓
Precipitation (45)
(2 1/2 tons detinned steel cans)
↓
Total: Cement copper (86)

Copper requires between 86 and 112 million Btu/ton. This high energy consumption stems from problems associated with the relatively low grade of the ore. Iron and steel require far less energy per ton of material produced. The flow sheet developed for the production of steel slabs appear as follows, beginning with the traditional open-hearth furnace approach.

Blast furnace (17.4)
↓
Open-hearth furnace (6.1)
↓
Ingot casting (0.74)
↓
Slabbing mill (1.9)
↓
Total: Steel slabs (26.1)

The basic oxygen furnace consumes slightly more energy than an open-hearth furnace because less scrap (and more hot pig iron) is used. The energy flow sheet shows 21.8 x 10^6 Btu/ton for the blast furnace and 2.8 x 10^6 Btu/ton for the basic oxygen refining operation, giving a total of 27.2 million Btu/ton.

The third steel process, the electric furnace, uses a 100 percent scrap feed. The energy flow sheet appears as follows

Scrap (0)
↓
Electric arc furnace (10.0)
↓
Ingot casting (0.74)
↓
Slabbing mill (1.9)
↓
Total: Steel slabs (12.6)

for a total of 12.6 x 10^6 Btu/ton. This low figure for steel from scrap represents a subsidy from the original blast furnace reduction of material making up the scrap. Note that in this case the iron is available for further recycling, whereas in cement copper the metal was consumed and therefore an energy charge. It is also a graphic demonstration of the importance of recycling.

The energy used by ten metal industries is summarized in Table 1. These ten metals accounted for 5.45 quads of the estimated total of 5.8 quads used by the primary metals industry in 1973, almost 8 percent of the country's total energy consumption. A minor amount of energy was imported in the form of bauxite, iron pellets, chromite, and other raw materials. For purposes of uniformity, however, the study assumed that all materials processing occurs in the United States. Energy imports are offset by energy exports in the form of finished products.

An important factor to be considered is the energy expenditures associated with using plentiful domestic resources of lower-grade ores. Bravard *et al.* calculated the added energy required for producing five metals from lower-grade ores. In the case of aluminum,

TABLE 1

Energy requirements for selected metals in the United States in 1973

Commodity	Product	Energy required	
		Per net ton product (10^6 Btu's)	Total (10^{12} Btu's)
Iron and steel	Steel slabs	24	3350
	Gray iron castings	34	366
	Carbon steel castings	42	54
Aluminum	Ingot	244	1170*
Zinc	Ingot	65	92
Lead	Ingot	27	23.9
Copper	Cement copper	87	14.9
	Refined copper	112	221
Chromium	High-carbon ferroalloy	61	15.8
	Low-carbon ferroalloy	129	19.5
Magnesium	Metal	358	42.0
Manganese	Ferromanganese	49.5	33.0
	Blast furnace	46	17
	Electric furnace	52	16
Titanium	Metal	408	8.2
Uranium	Uranium oxide		
	Acid circuit	776	2.1
	Alkaline circuit	1123	2.2
	Resin-in-pulp	795	2.3

*In practice, 40 percent of aluminum electrical energy in the United States is derived from hydroelectric plants. The figure 244 × 10^6 Btu/ton in the Battelle report is reduced to 204 × 10^6 Btu/ton in calculating total U.S. use of 1.17 quads.

lower-grade bauxite or clays would be favored over anorthosite for long-term development, the processing costs being nearly equal. The problems associated with processing lower-grade ores are due to the increased volume of material, which requires higher energy inputs for mining and transportation and a greater percentage of the total energy to be used in crushing and grining. Kellogg concluded that the most important element is the grade of ore. This is demonstrated in Table 2, taken from unit studies of the Battelle report.

TABLE 2

Energy expenditures in mining and concentrating selected metallic ores

Commodity	Grade (%)	Tons ore per ton metal	Energy per ton product (10^6 Btu's)		Percentage of total product energy
			Mining	Concentration	
Iron	30	4	0.61*	2.0	11‡
Zinc	10‡	12	5.3	5.2	7
Lead	10‡	12	4.3	4.5	30
Copper	0.7	157	21.6*†	42.3	57
Uranium	0.2	530	332.4*	246.6	58

*Surface mining. †Pellets. ‡Estimated.

The results given in Table 2 can only be considered indicative. For instance, 36 percent of uranium is mined underground, and the mining energy for that portion would be several times higher than the energy for surface mining. The general trend is shown by the rising energy costs of mining lower-grade nonferrous ores. It is only the increased use of energy through mechanization that has made mining of such ores economically possible. Lovering estimated that while U.S. mineral production rose 50 percent in the last 50 years, energy consumption went up 600 percent in the last 25 years.

There are three ways to counter this: (i) using better technology, such as a cheaper grinding process or *in situ* leaching; (ii) recycling, which uses 50 to 30 percent of the energy required to produce metals from ores; and (iii) making better use of the metals we produce--for example, doubling the life of an automobile.

Nonmetallic Materials

The nonmetallic sector consumed 1.9 percent of the total U.S. energy in 1973, and half of this was in Portland cement production alone. Some of the largest users in this class are shown in Table 3. As a class, nonmetallics are much lower in energy intensiveness per ton than metallic materials. This is because they are much more common in nature, and they are generally processed "as is" without reduction of oxides or silicates or breaking of chemical bonds. How-

TABLE 3

Energy requirements for selected nonmetallic materials for primary products in the United States in 1973

Commodity	Product	Energy required	
		Per net ton product (10^6 Btu's)	Total (10^{12} Btu's)
Calcium	Quicklime	8.5	182
Cement	Portland cement	7.6	688
Ceramics	Common brick	3.5	62
Glass	Glass containers	17.4	216
Refractories	Basic brick	27	18.2
	Fireclay brick	4.2	6.9
Clays	Kaolin	2.8	14.3
Gypsum	Other clays	0.1-5.3	16.7
	Calcined gypsum	1.5	19
Sand and gravel	Sand and gravel	0.056	52
			1276.1

ever, they are highly transportation sensitive. Truck transportation of sand and gravel, for an average of 20 miles, uses more energy nationally than the magnesium industry. Thus, materials can be energy intensive like titanium, with a high energy requirement per ton, or they can be low like cement, but the national aggregate is substantial.

Energy Costs of Fuels and Electricity

A national energy accountability system also requires knowledge about energy inputs to such industries as coal mining, petroleum refining, and natural gas transmission. Adding their processing costs to the thermal value of the fuels produces total energy costs. In its own right, the extraction, conversion, and transportation of energy is the most energy-consuming sector of the American industrial scene. More than 20 percent of the gross energy of fuels is consumed in bringing energy to the materials processor. In practice, as described in this article it is necessary to start with gross energy in arriving at energy costs per unit of material and, in effect, assign all these energy losses to specific materials. The energy unit costs of petroleum, natural gas, coal and electricity will only be covered in general terms.

Coal production involves relatively low extraction and transportation losses per ton. Capital, materials, and equipment, estimated at 2 percent of the fuel value, would represent 500,000 Btu/ton. The Bureau of Mines estimates that in 1973 it required 31,300 Btu's to mine and prepare a ton of coal for market. It is estimated that the transportation energy is 330,000 Btu/ton--a total of 861,000 Btu/ton of delivered coal.

Petroleum is not such a simple case. Capital and equipment costs probably represent 2 percent of the fuel value. The extraction fuel value would add another 2 percent. Transportation by pipeline and tanker to a refinery also represents about 2 percent of the crude energy value. The refining operation itself uses tremendous amounts of petroleum fuels, natural gas, and electricity, which translate to more than 700,000 Btu's per barrel of crude oil. This amounts to 11 percent of the total energy to refineries, counting both crude oil and auxiliary fuels. On a national scale, it amounted to 2.83 quads in 1968 or 4.7 percent of the total energy of the United States. Thus, the petroleum industry consumes about 17 percent of its own energy equivalent in going from exploration to distribution of refined products.

In the United States 3 percent of all natural gas is used as transportation fuel for pumping gas from well to consumer. Equivalents of fuel used in extraction probably account for 2 percent. Other energy costs represented by equipment and capital are also estimated at 2 percent, so that 93 percent of the fuel value is delivered.

The energy costs of bringing fossil fuels to market are shown in Table 4. In energy accountability this shrinkage is assigned to specific classifications such as extraction, petroleum refining and transportation.

TABLE 4

Energy costs of bringing fossil fuels to market

Commodity	Energy used	
	Percent	Btu's per 10^6 Btu's
Coal	3	30,000
Petroleum	6	60,000
Petroleum refining	11	110,000
Natural gas	7	70,000

Electricity, a secondary energy form, is far and away the most expensive in terms of energy costs. Yet, it is the fastest-growing sector. Some two-thirds of the input energy of the fossil (as well as nuclear) fuel used in electric power generation is dissipated, either in its transmission to the user or up the smokestack and down the river in the cooling water. In 1971 the United States consumed 25 percent of its gross fuel inputs to produce electricity. It used a gross of 17.4 quads, and "lost" the greater part of 11.9 quads in the production and transmission processes (some small fraction of the waste heat was used). In comparisons of energy per unit of output, the conversion of electrical energy has to take this loss into account. Theoretically, the conversion of 1 kilowatt-hour of electricity provides 3413 Btu's, but more than three times that much thermal energy is needed to generate and transmit that much electricity. A figure of 10,400 Btu's (thermal) based on actual industry measurement is generally used in this country. This figure has come down from a rate of 15,600 Btu's per kilowatt-hour in 1947.

In summary, the energy inputs of fuels for materials processing in the United States in 1971 were 12.56 quads for coal, 30.49 for petroleum, 22.73 for natural gas, 2.80 for hydroelectric power, and 0.41 for nuclear power--a total of 69 quads. Prorating electricity conversion losses and subtracting 5.7 percent for nonfuel uses (feedstocks, lubricating oils, and road materials) gives a net energy output of 57 quads.

Energy Costs of Plastics and Chemicals

More than 90 percent of the feedstock of fuel and petroleum products in the United States is used in a half-dozen chemical industries. Gross energy inputs can be measured, as well as energy contained in the primary products. Past this point, the distribution or determination of energy per unit material becomes stickier. For instance, ethylene accounts for not only its own feedstock requirements, but also those of ethylene oxide, ethylene glycol, and, in

part, ethylbenzene and styrene. It is beyond the scope of this article to trace out allocations of energy below the primary processing step.

The industrial use of energy for 37 selected chemicals in six Standard Industrial Classifications (SIC's) in 1973 is shown in Table 5. The total represents 4.8 percent of all U.S. energy in that year. The six largest energy consumers in this group are shown in Table 6.

TABLE 5

Energy requirements of six SIC groups in 1973.
(Numbers in parentheses identify SIC groups)

Industry	Energy (10^{12} Btu's)		
	Process	Feedstock	Total
Alkalies and chlorine (2812)	475.8	0	475.8
Industrial gases (2813)	110.5	48.9	159.4
Inorganic pigments (2816)	35.1	0	35.1
Industrial inorganics (2819)	442.5	345.6	788.1
Cyclic intermediates (2815)	70.1	158.7	228.8
Industrial organics (2818)	556.9	1273.5	1830.4
Total (281)	1690.9	1826.7	3517.6

The phenomenal growth of the plastics industry merits special attention. The process energy requirements range from 45-70 million Btu/ton for polystyrene to 135 Btu/ton for low-density polyethylene. The plastics produced in the United States in 1973, estimated at 14 million tons, required 1.4 quads of process energy, making plastics a larger consumer than the aluminum industry. The stored energy in the finished plastic is roughly equivalent to the hydrocarbon input and requires a raw material input of 0.6 to 0.8 quad. The only way to recover this energy is by combustion. This demonstrates that the plastics industry is one of the largest users of materials processing energy. However, unlike scrap metal, the material discarded by consumers can only be recycled as a fuel because of the present limitations of resource recovery technology.

Implications

Processing of many materials could become energy-limited rather than resource-limited. The methods required to provide metals, industrial minerals, and energy fuels and materials in useful forms all consume significant quantities of coal, oil, gas and electricity. The materials industries use more than 20 percent of the nation's energy in processing

TABLE 6

Six largest users of energy in SIC group 281 in 1973. Only feedstocks not accounted for by one of the other selected chemicals are included. For example, benzene is charged against styrene while ethylene is not.

Chemical	Tonnage (10^9 pounds)	Energy consumption (10^{12} Btu's)		
		Process	Feedstock	Total
Ethylene (2818)	33.4	382.3	1078.0	1460.3
Ammonia (2819)	30.3	271.7	345.6	617.3
Chlorine (2812)	19.2	398.6	0	398.6
Styrene (2815)	6.0	51.1	86.6	137.7
Methanol (2818)	7.04	34.3	91.7	126.0
Acetylene (2813)	0.58	8.27	38.8	47.1

metals (8 percent), chemicals and allied products (7.8 percent), petroleum refining (4 percent), and nonmetallics (2 percent). Steel, aluminum, plastics, cement, and gasoline account for half of this. The issue becomes complex when one considers that each material has its own level of energy intensiveness and that there are ways in which energy can be lost or saved in the total economic system. Despite those problems, certain broad implications emerge for metallic, nonmetallic, and energy materials.

The data available for metallic minerals are the best defined, and their significance in the economy carries a clear requirement that energy intensity be considered in planning for their extraction and usage. Within that context, it becomes tempting to oversimplify the problem. For example, some 25 x 10^6 Btu's are needed to produce a ton of steel and 245 x 10^6 Btu's to produce a ton of aluminum. Thus, energy accounting might appear to mandate use of steel in preference to aluminum. But a ton of steel occupies one-third the volume of a ton of aluminum, so that substituting aluminum would greatly lower the energy savings per volume of material used. Further, for goods that are transported or used in transportation, lighter-weight materials provide additional energy savings. The same reasoning applies to plastics. Thus, energy accounting cannot provide as simple an answer as might be assumed from the initial data.

One clear planning precept does emerge, however. Each material has a fixed lower bound of ore grade, below which energy costs make

processing uneconomic. The energy costs rise rapidly as ore grade decreases. At some lower limit, say 0.25 percent, the energy expenditures dominate the whole recovery picture. Technological improvements in rock disintegration, transportation, and concentration will have to be made if such low-grade ores are to be considered as reserves--that is, resources that can be processed economically.

In the case of energy materials, both extraction and refining have serious energy implications for the economy. As extraction becomes more difficult, and as more refining takes place, more energy is lost. For example, two-thirds as much oil as has ever been found is still in the pores of the host rock. One of nature's contributions to oil extraction has been the pressure of the accompanying natural gas, which forces petroleum through pores to collection centers of drilled wells. Most secondary methods of recovery involve pumping of various chemicals and fluids to force out the oil. The pumping energy alone places finite limits on the amount of total petroleum eventually recovered from different reservoirs. Also, more energy is used today in the search for oil--40 years ago 275 barrels of oil were found per foot of hole drilled; the comparable figure today is on the order of 25 barrels.

The refining of petroleum presents one example of energy losses incurred in making a fuel more useful. Conversion of solid coal into more useful products by gasification or liquifaction presents another example. About 10 to 20 percent of coal energy is expended in making a low-Btu gas (170 Btu's per cubic foot) and another 15 to 25 percent is used in upgrading it to pipeline quality gas (1000 Btu's per cubic foot). Electricity, the most ubiquitous and concentrated energy form, offers the ultimate example of energy losses incurred in a refining process.

The interweaving of energy losses in metallic and energy-mineral processing can be dealt with, but only through a total systems analysis. Such analysis, of true energy costs and possible real energy savings, is required if industry is to meet society's demand for materials in a world where energy, in all forms, is becoming increasingly expensive.

[Extracted from Science, Vol. 191, No. 4227, February 20, 1976, pp. 661-5.

Limits to Exploitation of Nonrenewable Resources

Earl Cook

[The limits to the world supply of resources--that is, of materials which may be extracted and put to use at a cost which does not exceed their value in use--are not only a matter of their presence in the earth's surface but of the costs of processing. These will change with technology; but the possibilities for cost reduction by new techniques are not infinite.]

Nonrenewable resources consist of geochemical concentrations of naturally occurring elements and compounds that can or may be exploited at a profit. The concentrations that are at present exploitable at a profit range from slightly more than twice to several thousand times the average crustal abundance of the desired element (Table 1). Rates of concentration into ore bodies or oil pools appear to be slow compared to the pace of human history. Moreover, the formation of deposits of ores and mineral fuels appears to require unusual or extraordinary geologic conditions; consequently, such deposits are unevenly distributed in space and time, and they commonly occupy very small portions of the earth materials in which they are found.

Almost 70 percent of proved crude-oil reserves are in the Middle East, and five countries produce more than 65 percent of the world's copper. These nonuniform distributions are real and do not merely reflect differences in exploration effort. Many of the most common ore deposits appear genetically and spatially related to the boundaries of "plates" moving on the earth's surface. Other ore deposits may be localized by uplift of the crust over thermal plumes. Pet-

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roleum as well as metallogenic provinces exist, and the world's coal deposits are strikingly concentrated in the temperate belt of the Northern Hemisphere.

TABLE I

Ratio of Cutoff Grade (the lowest concentration economically recoverable in 1975) to Crustal Abundance (average amount of the element found in the materials of the earth's surface)
Values are parts per million (ppm)

Element	Crustal abundance (ppm)	Cutoff grade (ppm)	Ratio
Mercury	0.089	1,000	11,200
Tungsten	1.1	4,500	4,000
Lead	12	40,000	3,300
Chromium	110	230,000	2,100
Tin	1.7	3,500	2,000
Silver	0.075	100	1,330
Gold	0.0035	3.5	1,000
Molybdenum	1.3	1,000	770
Zinc	94	35,000	370
Uranium	1.7	700	350
Carbon	320	100,000	310
Lithium	21	5,000	240
Manganese	1,300	250,000	190
Nickel	89	9,000	100
Cobalt	25	2,000	80
Phosphorus	1,200	88,000	70
Copper	63	3,500	56
Titanium	6,400	100,000	16
Iron	58,000	200,000	3.4
Aluminum	83,000	185,000	2.2

Not only are geologic resources distributed unevenly over the surface of the globe, they are concentrated in the outermost part of the earth's continental crust. Mechanisms that concentrate chemical elements operate most effectively on and near the earth's surface: weathering, erosion, sorting during transport, groundwater leaching, and supergene enrichment are effective only in the upper few hundred meters of the continents. Hot metal-bearing solutions encounter the precipitating effect of colder meteoric waters and find relatively high permeability only in the upper few thousand meters of the earth's crust. Oil and gas formation, migration, and entrapment take place within the thin and discontinuous sedimentary skin of the continents. There is a hoary myth among old prospectors that ore bodies widen and get richer downward. In fact, they generally do just the opposite. The rich gold and silver deposits of the American cordillera are notorious for bottoming at depths of a few tens to a thousand meters. The world's greatest oil well, Cerro Azul No. 4 in Mexico, after producing more than 40 million barrels of oil, suddenly produced only salt water.

The limited nature of individual deposits, the difficulty of seeing through rock, and the history of many mining districts and oil fields have led to many forecasts of depletion and exhaustion. But, as old deposits have become exhausted and new one have become harder to find, world mineral and fossil-fuel production paradoxically has continued to increase. There is a wide difference of opinion now on the question of limits to the exploitation of nonrenewable resources.

Three Kinds of Limits

To the mining or petroleum engineer, the profit of exploitation is defined by the difference between the price received for his product and the pecuniary costs of recovering the natural material and turning it into a salable product. To society, however, the profit from mining (including oil and gas extraction) can be defined either as an energy surplus, as from the exploitation of fossil and nuclear fuel deposits, or as a work saving, as in the lessened expenditure of human energy and time when steel is used in place of wood in tools and structures. In this context, the exploitation of earth resources for display, adornment, or monetary backing is a deficit operation, financed by energy profits from other kinds of mining.

The ultimate limit to exploitation of earth resources then is the limit of net energy profit (or work savings). When it takes more energy to find, recover, process, and transport the fossil fuels than can be gotten from them in useful form, there will be no more oil, gas, or coal resources. When it takes so much energy or work to produce a nonenergy material that one must sacrifice other, more needed items or services to pay for it, there will be no more resources of that material. Short of this energetic limit, one or both of two other limits may intervene. First is the limit of comparable utility. A resource is a resource only while it can be used to perform a function desired by man better or more cheaply than can another substance. If the energy cost of an earth resource such as crude oil rises to a level at which another substance, such as synthetic crude oil from coal, can be substituted in adequate volume at a lower cost for comparable utility, substitution will take place, with the first resource reverting to a mere geochemical anomaly and the source of the replacing substance becoming a resource.

The limit to a resource also may be determined by the unwillingness of society to pay the cost of its exploitation, even though an energy surplus (or saving) might be obtained thereby. Many primitive societies have preferred to take their energy surplus in leisure rather than in goods (stored energy or work) and deliberately abstained from exploiting available potential resources that could have increased their surplus. Some primitive agricultural societies still do this. A modern decision to forgo the calculable energy benefits

of the breeder-reactor power plant would again invoke this limit of living-level degradation, a limit that comes into play when a society is not willing to pay the total costs of production because so doing would, it is judged, lower the level of living more than would forgoing use of the resource.

Effects of Technology and Cheap Energy

To some, the history of nonrenewable resource exploitation seems to contradict the idea of an energetic limit short of mining common rock and "burning" seawater. During the past 150 years large increases in the earth-resource base of industrialized society have been attained. By increasing the efficiencies of discovery, recovery, processing, and application of such resources, we have been able to find and exploit leaner, deeper, and more remote deposits. By discovering and developing new methods of utilizing previously worthless materials we have created resources where none existed. Important in this rapid technologic advance has been a progressive lowering of the cost of energy per unit of work, or of useful heat obtained. Cheaper energy, along with technological ingenuity and discovery, have greatly extended the availability of nonenergy resources. In 1900 the lowest grade of copper ore economically minable was about 3 percent; today the economic cutoff has fallen to about 0.35 percent. At that grade each ton of refined copper produced requires the breaking, transport, and milling of almost 300 tons of rock and, in addition, the removal of perhaps an equal amount of waste or barren rock. A great deal of energy--about 26,000 kilowatt hours, the equivalent of the energy in about 4 metric tons of Wyoming coal--is required to produce a metric ton of copper today, but the cost of that energy is still low compared to the cost of supporting the equivalent in men and mules.

Many past forecasts of the exhaustion of one or more earth resources have come to appear almost wildly inaccurate in the light of later production. Forty years ago, geologist C. K. Leith, for example, called attention to the coming exhaustion of U.S. mineral resources, claiming that "despite a magnificent endowment [of metals and fuels], depletion is further advanced than even mining men generally realize." At the time Leith wrote, proved reserves of crude oil, zinc and lead in the United States were 15 to 20 times the annual production rates, the Lake Superior iron ores appeared to have less than 20 years of measured supply remaining, and known copper reserves were about 40 times the 1934 production. Leith went on: "Further discovery and the use of lower grade resources will extend the life of most of these resources, but the range of possibilities is now pretty well understood, and with maximum allowance for such extension, the figures are sufficiently small, when compared with what we hope will be the life of the nation, as to be matters of public concern... Discovery has not stopped, but the rate has been slowing... Of 33

metal-mining districts that have yielded the greatest wealth to date only 5 have been discovered since 1900 and none at all since 1907... The rate of discovery of oil and gas continues high...but the chances of finding another East Texas or Kettleman Hills are not promising."

Well, what happened? Since 1935, the United States has produced more zinc that it did before that year. In 1974 the U.S. mine production of zinc (Table 2) could have been maintained for 61 years on the then-known reserves. The ratio of domestic reserves to primary consumption, defined as domestic production plus imports minus the recycled or second supply, stood at 24 (see last column of table) although demand had soared. U.S. lead production since 1935 does not equal the pre-1936 total, but the ratio of measured reserves to primary consumption in 1974 was 67, and the 1974 mine production could have continued for 87 years without further discovery.

TABLE 2

COMPARISON OF THE RATIO OF UNITED STATES RESERVES TO PRODUCTION (R/P) IN 1934 WITH THE SAME RATIO AND THE RATIO OF RESERVES TO PRIMARY CONSUMPTION (R/Cp) IN 1974 FOR FIVE MAJOR EARTH RESOURCES

Resource	1934 R/P (approximate)	1974 R/P	1974 Domestic mine (well) production	1974 Net imports (primary and secondary)	1974 Domestic secondary supply	1974 Domestic reserves R	1974 Domestic primary consumption (Cp)	1974 R/Cp
Copper[1]	40	57	1,441	391	455	81,800	1,640	50
Iron Ore[1]	18	24	83,000	46,000	NA*	2,000,000	140,500	14
Lead[1]	15-20	87	615	82	564	53,600	800	67
Zinc[1]	15-20	61	447	655	77	27,300	1,150	24
Crude oil[2]	15-20	11.2	3,043	1,268	NA*	34,250	4,447	7.7

*NA, not applicable.
1 in metric tons; source U.S. Bureau of Mines.
2 in millions of barrels; various sources

The Lake Superior iron ore of Leith's day has been virtually exhausted, but it has been largely replaced by taconite, a low-grade iron-bearing rock not considered to be ore in 1935. The 1974 ratio of measured reserves to U.S. iron-ore consumption was 14, and at the 1974 rate of U.S. mine production the reserves would last about 24 years. Since 1935, more copper has been mined in the United States than before. Based on 1974 figures, the ratio of reserves to primary consumption was 50, and U.S. mine production could have continued at the 1974 level of 57 years without new discoveries.

More recoverable crude oil (77.3 billion barrels) has been discovered since 1935 than was produced from 1857 through 1934 (62.0 billion barrels). At the end of 1974, however, the ratio of proved

reserves to 1974 production was only about 11. Perhaps more significantly, the ratio of proved domestic reserves to 1974 consumption (of both domestic and foreign petroleum) was only 7.7.

In regard to these major earth resources, then, the United States in 1975 was substantially worse off than it was in 1935 only in crude oil. Despite large increases in consumption rates over the past 40 years, we now have many more "years" of lead reserves than we did 40 years ago, as well as about 25 percent more years of copper and zinc reserves--even if we were abruptly deprived of all imports of these metals. With continued imports, our iron-ore reserve position is much better than it was 40 years ago; without imports, we have lost only 4 years of reserves in 40 years. In the short term, and except for oil, Leith appears to have been wrong. [Note: Although this example covers only United States resources, it is similar to the kind of result found in world resource calculations.] The continuous-creation school of resource analysts would classify him as a doom-sayer of the past whose forecasts went awry for the same reason that those of the present-day Cassandras will miss the mark, a lack of understanding of the impact on reserves of continuously improving technology, which geologist Nolan once called "the inexhaustible resource."

The view that advances in technology, stimulated by the market economy, will prolong the availability of a mineral commodity almost indefinitely or will provide adequate substitutes when rising cost begins to slow demand, has much evidence in its favor and many strong adherents. There is currently [1975] an oversupply of both copper and crude oil in the world, and the supply of ores of iron and aluminum, despite enormous increases in the production and consumption of both during the past 50 years, seems almost boundless.

Why, then, do some persist in the opposite view, that physical limits will slow or halt the development and utilization of most earth resources long before crustal concentrations can be regarded as reserves? Perhaps it is because they are impressed by the steepness of the geochemical gradients at the margins of most ore and fossil-fuel deposits, by the fact that such deposits do not show a compensating increase in tonnage of reserves (calculated as recoverable metal or fuel) as grade decreases, by the environmental limitations on their origin, and by the fact that the energy or work cost of recovery increases exponentially with decreasing grade of the ore or with increasing cumulative recovery in the case of crude oil.

Examples of Exploitation Limits

The so-called porphyry copper deposits, which now produce more than half the world's copper, are worth looking at in the context of exploitation limits. They are sharply restricted in age of formation to three geological periods within the range of 30 million to 200

million years ago. They are associated with small intrusive bodies of stocklike form, averaging 1200 by 2000 meters in outcrop. The ore bodies tend to be pipelike and oval in plan, with dimensions of approximately 1000 by 2000 meters. Mineralization is in concentric zones, with the copper content in the center of the body reaching ten times that at the outer edge of metallization. Vertical dimensions can reach 3000 meters, but the pipe narrows downward. If, as Sillitoe believes, the porphyry copper deposit spans the boundary between the plutonic and volcanic environments, it occupies a very special geologic position indeed, sharply limited in both time and space.

The Toquepala and Cuajone mines in Peru are typical of the porphyry coppers. The mass of mineralized rock in these deposits has the shape of an inverted and truncated cone, within which the copper content ranges from 1.32 percent to less than 0.45 percent, the present cutoff grade below which mining and processing would be unprofitable. Rock containing between 0.20 and 0.45 percent copper is, however, being mined and stockpiled for later leaching by sulfuric acid. Below an average of about 1 percent copper, the copper content of the ore (Table 3) decreases sharply as the grade drops. The deposits, with the ore minerals irregularly disseminated through them, have rather sharp geochemical boundaries, and the diameter of the mineralized cone decreases downward. The energy cost per ton of refined copper of mining and milling the ore increases inversely with grade, and directly with depth.

TABLE 3

Relations of ore grade, copper content, and mining and milling energy at Cuajone mine, Peru. Values in the last column are Δ per short ton of copper, where Δ is the energy required to mine and mill a short ton of 1.00 percent copper ore. (To convert short tons to metric tons, divide by 1.1023.)

Average grade (%)	Tonnage (thousands of short tons)	Copper content (thousands of short tons)	Energy needed to mine and mill (Δ/ton)
1.32	20,000	264	0.76
0.99	430,000	4,257	1.01
0.32	102,000	326.4	3.13
< 0.20*	1,057,000	66.6*	> 16,000

* Mostly barren overburden of post-ore volcanic rocks; calculated at crustal abundance for copper content and energy needed.

At Cuajone, if the ore cutoff grade were to fall from the present 0.45 percent to 0.20 percent, the total copper recovery would be increased by only 7 percent. At Toquepala, a similar lowering of the cutoff grade would increase recoverable copper by less than 4 percent. Because economies of scale appear to have been exploited fully, and because energy costs are rising, it does not appear likely that the ore reserves in these mines will be extended much either by technological advances or rises in the price of copper.

A tonnage-grade analysis of known North American porphyry copper deposits indicates that 70 percent of the copper metal is in deposits above 0.7 percent copper; lower-grade deposits do not represent increasingly larger amounts of copper, but the reverse. Analyses of the known deposits of the two other principal types of copper deposits, strata-bound and massive sulfide, suggest similar tonnage-grade relations. Significant, too, is the fact that the rate of additions to reserves of copper metal appears to have been falling off since 1960, during a period when the price of copper has risen strongly; here it is important to distinguish between tonnage of ore and tonnage of contained metal. Many more deposits will need to be found, and at a faster pace than recently, if copper production is to continue at high levels into the coming century. Furthermore, there appears to be a geochemical barrier to copper recovery at about 0.1 percent copper, below which most copper is in solid solution in common silicate minerals and is not amenable to selective physical or chemical extraction.

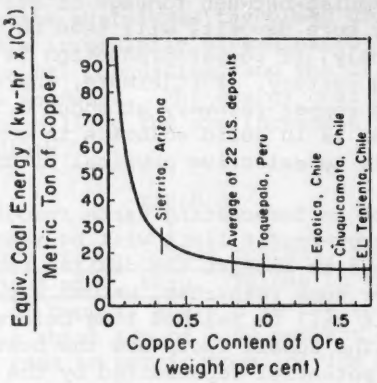
The basic question in forecasting earth resource exhaustion is whether or not the energy-profit limit will be reached, or demand will cease, short of attempts to extract the desired resource from ordinary rock and seawater. For some resources, we can say with assurance that the energy-profit limit will be reached long before ordinary rock can be mined profitably. The fossil fuels are the best and most important examples. The energy potential represented by the average concentration of carbon in the earth's crust is 2.9 kilowatt-hours per metric ton, not nearly enough to crush and grind it to liberate the carbon for use. We can thus be sure that the sharp physical boundaries that characterize coal and petroleum deposits are also economic boundaries. In fact, for most petroleum deposits the economic limit of exploitation lies within the deposit rather than at its margins; oil clings so tenaciously to the pore walls of reservoir rocks that to flush it all out would require more energy than can be gotten from it. The curve of incremental recovery against energy cost is steeply exponential for so-called tertiary recovery techniques, and to achieve an average cumulative recovery ratio of even 40 percent from American reservoirs will require much higher prices for oil than can now be foreseen.

On the other hand, there are very large low-grade deposits of uranium in which the potential energy is more than sufficient to break, transport and pulverize the rock, and then to recover the uranium.

Breeder reactors converting 60 percent of the potential energy of uranium to thermal energy and 40 percent of that to electricity could produce more than 5500 kilowatt-hours per metric ton of average crustal rock, which might allow an energy profit to be returned. The question here is the amount of energy required for mining and milling very low grade ore. Not only does the tonnage of ore necessary to produce 1 ton of metal increase hyperbolically as the grade decreases (Fig. 1), but the energy input per ton of ore ground increases as the size required to liberate small particles of ore decreases.

FIGURE 1

Equivalent Coal Energy Requirements for Different Grades of Copper Sulfide Ores. Grades of some copper deposits are shown. Source: N. J. Page and S. C. Creasey, J. Res. U.S. Geological Survey, 1975.



As ore grade decreases, the percentage of the valuable metal recovered in milling decreases; this falling off in recovery efficiency has the effect of increasing the energy cost per unit of refined metal. Finally, the ore generally gets harder to break and more expensive to lift as mining goes deeper; therefore, the energy costs of mining (per ton of recovered metal) tend to increase as exploitation continues.

In general, the energy required to produce refined metal from low-grade ores becomes extremely high at grades that, except for iron and aluminum, are well above the corresponding crustal abundances. Except in the cases of strip-mined coal and Persian Gulf oil, the energy costs of obtaining useful energy are rising as found sources grow deeper, leaner, and more recalcitrant or refractory. Coal exploitable by stripping and Persian Gulf oil are clearly finite, and production of both is

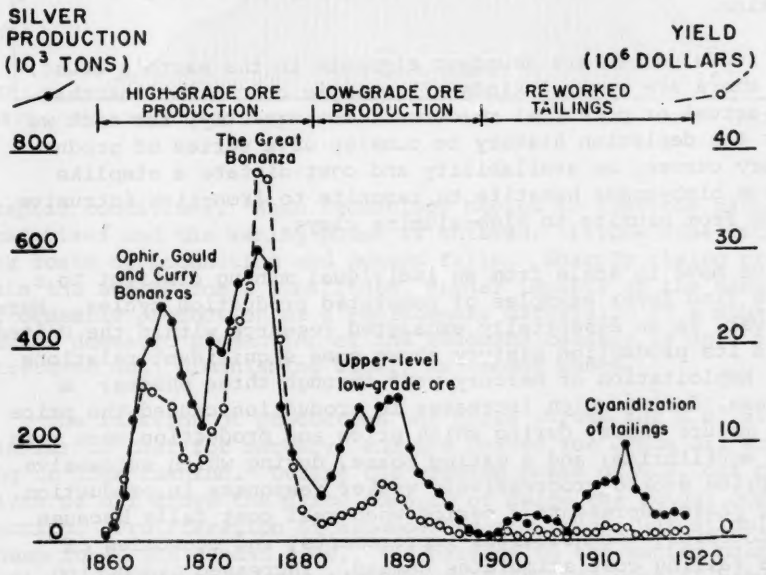
likely to wane within 25 to 50 years. Increased costs of obtaining useful energy, and higher work costs of exploiting leaner or more refractory materials, will tend to raise present ore cutoff limits and thereby to reduce reserves, while technologists continue the struggle to lower cutoff grades and augment reserves. Only a breakthrough of new technology that results in a substantial lowering of energy costs would reverse what appears to be a tightening of the drawstring on nature's bag of nonenergy resources. The breeder reactor may represent such a breakthrough; fusion might some day be another.

Depletion Histories

The history of a mining district or of an oil field has a beginning and an end, separated by a productive period. Some histories end abruptly, others are drawn out. Resurrection is rare. The history of the Comstock silver lode (Fig. 2) illustrates a simple depletion pattern characteristic of high-grade, sharply bounded, vertically limited mineral deposits.

FIGURE 2

Production history of the Comstock Lode in Nevada. The data for 1860-1881 are from E. Lord; the data for 1882-1920 are from G. H. Smith.



The system is rich an intricate near the surface, barren and simple a few thousand feet below. Its production history shows three distinct stages: in the first stage, during which the greatest part of the lode's total value was extracted, high-grade ore was mined at a fast rate. In the second stage, it became possible because of technological improvements to mine lower-grade material bypassed in the first stage. In the final stage, waste material and some very low grade ore were processed by a new technology, but little was added to the value already produced.

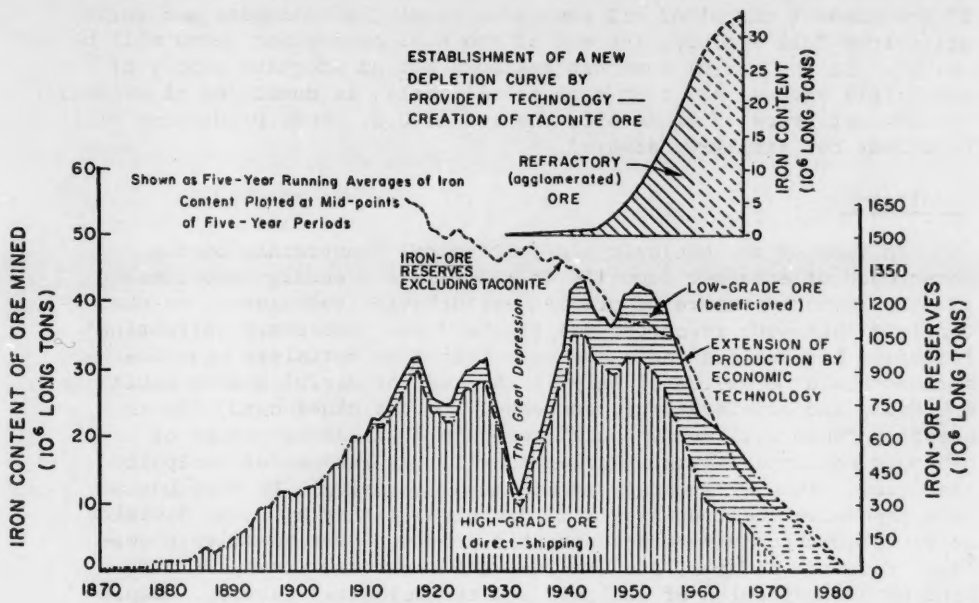
Somewhat different from the history of the Comstock is that of the Lake Superior iron district. Depletion of the rich "direct shipping" ores of that district is almost complete (Fig. 3). These ores, created by a geologic process related to groundwater levels and to the particular geologic configurations of the district, had sharp physical boundaries that coincided with economic limits. In the waning stage of production, upgrading of low-grade material into shippable concentrates added substantially to total production, but delayed exhaustion by only a few years. However, the Lake Superior district has been revived through a technological breakthrough that created a very large resource out of a previously worthless iron-bearing rock called taconite. Such provident technology can be effective only where there is a deposit, already concentrated by natural processes, characterized by a refractory host or reservoir rock. Taconite production, now in its youthful stage, will also pass through maturity to exhaustion.

Iron and aluminum are abundant elements in the earth's crust. For each, there are several kinds of geologic concentrations that represent actual or potential resources; consequently, for each we may expect the depletion history to consist of a series of production history curves, as availability and cost dictate a steplike descent from high-grade hematite to taconite to iron-rich intrusive bodies; and from bauxite to high-alumina clays.

When we move in scale from an individual mining district to a country, we find fewer examples of completed production cycles. Mercury, however, is an essentially exhausted resource within the United States, and its production history shows some significant relations to price. Exploitation of mercury went through three phases: a growing phase, during which increases in production caused the price to fall; a mature phase, during which price and production were more or less in equilibrium; and a waning phase, during which successive surges in price evoked progressively weaker responses in production. The growing phase represents a period when real cost falls because of new discoveries, technological improvements, and economies of scale. The falling cost stimulates demand. Increased production hastens the exhaustion of high-grade, low-cost deposits and puts pressure on technology to counter increasingly adverse geologic and geo-

FIGURE 3

Depletion history of Lake Superior district iron ore, showing overlapping stages of depletion of a mining region.



graphic conditions. When technology begins to lose the battle, real cost rises and the waning phase is entered. Prices rise with increasing costs of production and demand falls. Sharply rising prices stimulate the search for a substitute, either imports of the same substance or domestic production of a replacement material. If a substitute is found, domestic production of the resource ceases; if not, it is stretched out, diminishing slowly as demand wanes.

The relation of production and price curves for U.S. silver is similar to that for mercury, and the curves for crude oil are developing in like fashion. During the growing phase of U.S. oil production, gluts of oil drove the price down to or below the actual cost of production. Proliferation of automobiles and trucks was stimulated by cheap fuel, and demand grew. The passage to the waning phase, about 1971, was abrupt because of the large cost differential between

domestic and foreign crude oil at a time of strongly rising demand, a differential that forced a rapid shift from domestic production to imports. Current, artificially high, world crude-oil prices have encouraged exploration for new domestic reserves and have stimulated new efforts to recover more oil from existing wells. It is almost certain, however, that we shall not see a production response equivalent to the price rise because the costs of finding and recovering crude oil (and natural gas) increase exponentially with depletion. If the present cartel of oil exporting countries collapses and world oil prices fall sharply, the end of the U.S. production curve will be abrupt. If the cartel does not collapse but an adequate supply of substitute energy, say from coal or oil shale, is developed at or near the present price of crude oil, the end of U.S. crude production will be slower but similarly assured.

Conclusion

In view of the geologic and geochemical constraints on the occurrence of economic deposits of minerals and energy resources, and the advanced nature of present exploitation techniques, we must conclude that such resources are finite. The "endlessly retreating" interface between ore and almost-ore that some optimists have described could be validated only if the cost of useful energy would endlessly and acceleratingly decrease. On the other hand, the question "When will we run out?" bespeaks a misunderstanding of geologic resource limits. The world will not run out of geologic resources. They will merely become more expensive. As they become more expensive their utility will diminish, either by human decision or by failure to achieve an energetic profit. How expensive a geologic resource becomes, and how fast its real cost rises, will depend on a combination of geologic and technological factors. Depletion (rise in cost) is swift for those materials found mainly in sharply bounded, highly concentrated deposits--especially swift if they cannot be recycled after use. Depletion is slow for abundant materials found mainly in deposits of relatively low geochemical concentration with gradational boundaries--especially slow if they can be recycled after use.

[Extracted from Science, Vol. 191, No. 4227, February 20, 1976, pp. 677-82.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1980—310-928/2

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